Gerhard Oswald
Michael Kleinemeier
Editors

Shaping the Digital Enterprise

Trends and Use Cases in Digital Innovation and Transformation

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Editors
Gerhard Oswald
SAP SE
Walldorf, Germany

Michael Kleinemeier
SAP SE
Walldorf, Germany

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Foreword

The chapters in this book offer possible answers to some of the pressing questions that arise when practitioners seek to shape a digital enterprise. The chapters are classified into three sections:

1. Cross-industry trends—chapters that primarily present industry-independent insights on digitalization.
2. Industry-specific trends—chapters that focus on digitalization in a specific industry.
3. Use cases—chapters that primarily deal with concrete examples of digitalization.

Chapters in the Cross-Industry Trends Section

Our introductory chapter, "*Digitalize or Drown*," shows first that digitalization, defined as the process of moving to a digital business, is the only reasonable reaction to persistent digitization in any industry. It then introduces a framework that can serve as orientation for digitalization.

In "*The Business Consequences of a Digitally Transformed Economy*," Kowalkiewicz, Safrudin, and Schulze describe how five emerging digitalization trends are pushing organizations to reimagine their business models, their business processes, and how these processes and models work in a digital economy. The authors present what the trend entails with ample examples and two important tasks for digital enterprises: digitize the core and digitize the mind-set.

Organizational change management continues to be a challenge, particularly when uncertainties arise as a result of the digital economy. In "*It's Not Just about Technology: The People Side of Digitization*," Kohnke highlights four major areas in organizational change management that should be considered when leading individuals in digital enterprises.

Companies must have solid innovation and transformation capability if they are to survive and stay competitive. In "*Antithetic Leadership—Designers Are Different, Business People Too*," von Kutzschenbach, Wagner, and Mittemeyer introduce the notion of "antithetic leadership" to describe this required duality in management behavior for digital enterprises to succeed.

In "*Digital Culture—Why Strategy and Culture Should Eat Breakfast Together*," Wokurka, Banschbach, Houlder, and Jolly suggest that one of the reasons digital transformation initiatives fail is that they collide with the company culture. The authors discuss how to avoid such failure by driving the necessary changes toward a digital culture.

In response to the challenges of the digital economy, Blaschke, Cigaina, Riss, and Shoshan's "*Designing Business Models for the Digital Economy*" introduces a methodology for systematic digital business modeling based on a language that both business and technology experts understand.

Chapters in the Industry-Specific Trends Section

The concepts of bitcoin and blockchain have revolutionized the banking and finance industry. In "*The Unbanked Don't Need More Brick-and-Mortar Banks*," Kehr, Tonkin, and Bihler describe how the blockchain model and mobile technologies are triggering a new era of mobile financial services in developing countries, potentially eliminating the need for brick-and-mortar banks.

As new digital technologies disrupt the automotive-supplier industry, Farahani, Meier, and Wilke's chapter "*Digital Supply Chain Management Agenda for the Automotive Supplier Industry*" presents a guiding agenda for bringing new technological innovations into use, cohesively based on the analysis of seventeen digital SCM use cases.

Companies in the manufacturing industry are reconfiguring their value chains to increase their service orientation. In "*The Value of Lifecycle Information to Transform the Manufacturing Industry*," Gudergan, Buschmeyer, Feige, Krechting, Bradenbrink, and Mutschler reveal the principles behind offering additional value through industrial product-service systems and advise best practices and management guidelines.

Chapters in the Use Cases Section

In "*Creating a Market Analytics Tool That Marketers LOVE To Use—A Case of Digital Transformation at Beiersdorf*," vom Brocke, Fay, Böhm, and Haltenhof address marketers' challenge with big data. The authors describe a joint initiative between Beiersdorf and SAP to establish a solution that marketers LOVE to use: a (L)ean process to produce the expected (O)utcomes that bring (V)alue to users and create (E)xcitement among the project team, its stakeholders, and its users. The user-centric market analytics tool allows Beiersdorf to reimagine its business processes through analytics automation and to reimagine work by shifting its perspective from "what" to "why."

The world is experiencing outbreaks of infectious diseases across geographies in magnitudes of size and speed rarely seen before. Moyer, Tom-Aba, Sharma, and Krause's chapter "*Taking Digital Innovation into the Field of Infectious Diseases—the Case of SORMAS®*" describes how a successful collaboration between several institutions jointly developed the Surveillance Outbreak Response Management and Analysis System (SORMAS), enabling an innovative approach to managing infections at their source using mobile and real-time technologies.

The Hilti Corporation has a long history of leveraging digital technologies to innovate and transform itself continuously. In "*A Journey of Digital Innovation and Transformation—The Case of Hilti*," vom Brocke, Fay, Schmiedel, Petry, Krause, and Teinzer report on the key activities, challenges, and success factors of each phase of Hilti's digital journey and discuss the lessons learned and their implications for digital enterprises.

Increasing the efficiency of car usage is one of the major areas of interest for sustainable mobility. In "*The Future of Automobility*," Janasz and Schneidewind present the efficiency potential of innovative mobility concepts, which flourish at the frontier of digital technologies, shared mobility patterns, and vehicle automation.

Condea, Hagedorn, and Cruickshank's chapter "*What Co-Innovation Can Mean for Digital Business Transformation—Sharing and Managing Risk To Achieve IT Business Innovation*" presents three co-innovation case studies with various SAP partners (Element Five, allvisual AG, Orianda Solutions, Wikitude, Mtell, and Rolta). The case studies show how each case leveraged co-innovation and contemporary technologies to achieve a successful digital transformation.

In "*Virtual Reality Goes Mobile in the Digital Age*," Poppe, Gilgen, and Safrudin show how three businesses—Samsung Italy, Tommy Hilfiger, and Biogen IDEC—embarked on a digital innovation initiative to get closer to their customers. Enabled by mobile virtual reality, the companies show how a purposeful use of digital technologies can bridge the divide between the real world and the virtual world.

We express our sincere thanks to all of the authors and all of the customers, partners, academic institutions, and other organizations involved in contributing to this book. Special thanks go to Michael Kleinemeier and Gerhard Oswald for editing the book; to our SAP Business Transformation Services consultants for

sharing their knowledge; to the dedicated book project team (Vivienne Zhong, Maria Fay, Tomasz Janasz, Roman Persiyantsev, and Pavel Balan), under the leadership of Niz Safrudin, for making it all happen; to Jan vom Brocke for comprehensive academic support; and to Barbara Bethke and Christian Rauscher from Springer Publishing for frictionless assistance and cooperation.

SAP Digital Business Services (DBS), Edward Schreckling
SAP Deutschland SE & Co. KG
Walldorf, Germany

SAP Digital Business Services (DBS), Christoph Steiger
SAP SE
Walldorf, Germany

Editors' Preface

The digital economy is real—and it is here to stay. We are witnessing an era unmatched in the history of business innovation and transformation. Breakthrough technologies have matured and hit scale together, enabling five defining trends (SAP 2015): hyper-connectivity, supercomputing, cloud computing, smarter world, and cyber security (see Fig. 1).

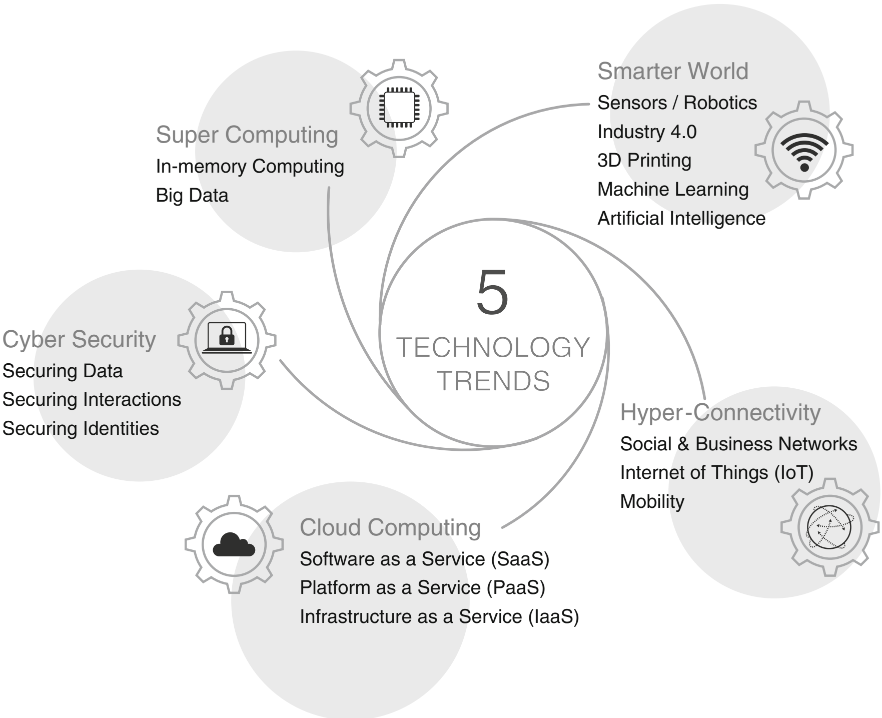

Fig. 1 Five technology trends (SAP 2015)

The resulting pace of change is staggering. Over the next 10 years, 40 % of the companies indexed as Standard & Poor's 500 will have ceased to exist (Ioannou 2014) unless they keep up with these technology trends. Winning companies are particularly agile in three areas (SAP 2015):

1. Reimagining business models
2. Reimagining business processes
3. Reimagining work

Leaders in the digital economy are emerging seemingly from out of nowhere (e.g., Uber, Airbnb). Digital business models are disruptive (e.g., in the automobile industry being affected by Google/Alphabet, Tesla, and Apple). Lines defining industries are blurring. Alibaba, for instance, is not just the largest e-commerce company; it is also a financial services and technology company. Every business is now a digital business.

Many CEOs believe the digital economy will have a major impact on their industry, but only a few have a digital strategy in place and execute it. Our CEO, Bill McDermott, has recently introduced a structured digital business framework that lets companies plan on how to develop and execute their digital business strategy (SAP 2015). This digital business framework comprises the following five pillars:

1. Engaged workforce
2. Supplier collaboration (Business Networks)
3. Core business processes
4. Assets and Internet of things
5. Customer experience (omni-channel)

Every company can develop a digital strategy across these five pillars. Research shows that companies having embraced the digital world and executed their digital strategy are seeing real shareholder and stakeholder value. Value creation through digitization strategies is significant, with +9 % revenue creation, +26 % impact to profitability, and +12 % market valuation (Westerman et al. 2013). When it comes to defining and enabling digital business strategies, SAP offers not only an end-to-end digital business solution (see Fig. 2) but also a corresponding digital service and support portfolio (SAP 2016, Oswald 2013).

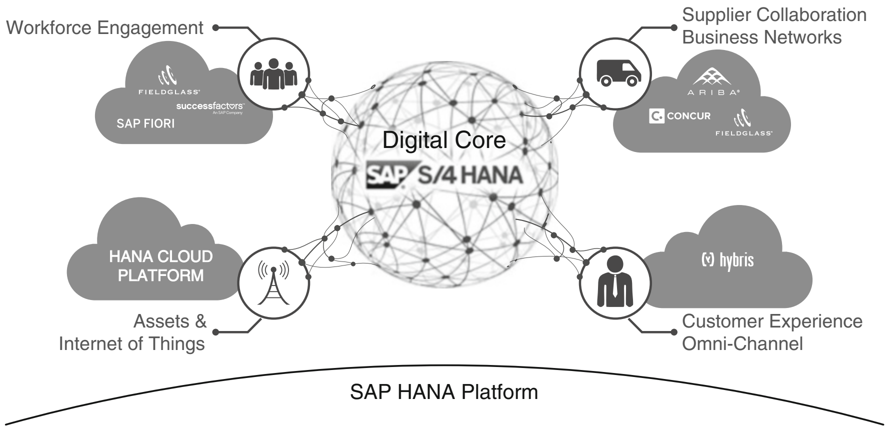

Fig. 2 SAP digital solution portfolio (SAP 2015)

The tremendous opportunities and challenges of digital innovation and transformation can only be mastered jointly in cooperation with customers and partners from different regions and industries, to the benefit of everyone involved.

Together with international researchers, consultants, and practitioners, the SAP Digital Thought Leadership & Enablement team within our Business Transformation Services (BTS) unit has in this book compiled key trends and case studies in digital business innovation and transformation. This collection of chapters, entitled "*Shaping The Digital Enterprise*," continues the successful SAP BTS book series by illuminating both the aspects mentioned above (technology foundation, business models, and processes) and further aspects of digital innovation and transformation (customer centricity, leadership and strategy, structure and governance, people and skills, and culture).

The editors would like to cordially thank all authors as well as all involved customers, partners, academic institutions, and other organizations for their contributions to this book. Special thanks goes to our Global Head of BTS, Dr. Christoph Steiger, and our Head of Digital Thought Leadership & Enablement team, Dr. Edward Schreckling, who initiated and conceptualized this publication.

SAP SE
Walldorf, Germany
Michael Kleinemeier

SAP SE
Walldorf, Germany
Gerhard Oswald

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Part I
Cross-industry Trends

Digitalize or Drown

Edward Schreckling and Christoph Steiger

Abstract Digitization, defined as the process of changing from analog to digital form, is inevitable, irreversible, tremendously fast, and ubiquitous. Drivers of digitization include digital technology breakthroughs; changes in people's behavior, attitudes and expectations; comparatively low barriers to entry; and the availability of huge amounts of venture capital. Objects of digitization are processes and work; products and services; and business models. The impacts of digitization include large and varied impacts on the economy as a whole, extraordinary opportunities, and significant challenges for businesses. Given digitization's characteristics and impacts, digitalization is no longer a choice but an imperative; for all businesses across all industries an regions the motto is digitalize or drown. The digital innovation and transformation framework introduced in this chapter—which is comprised of the eight dimensions of customer centricity; leadership and strategy; business models, including offerings (products and services); processes; structure and governance; people and skills; culture; and technology foundation—can serve as an orientation to digitalization.

1 Digitization: Drivers, Objects, and Impacts

As we write this chapter, the participants in the Annual Meeting of the World Economic Forum in Davos are discussing whether we are on the cusp of a fourth industrial revolution (Parker and Thomson 2016).[1] Most of the Davos participants think so.

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[1]The founder and executive chairman of the World Economic Forum, Klaus Schwab, characterizes the first three industrial revolutions as follows (Schwab 2016a, b):

1st (1760–1840): railroads, steam engine, water, mechanical production equipment.

2nd (late nineteenth century–early twentieth century): division of labor, electricity, assembly line, mass production.

3rd (1960s—present): electronics, IT, automated production, catalyzed by the development of semiconductors, mainframe computing in the 1960s, personal computing in the 1970s and 1980s, and the internet in the 1990s.

E. Schreckling (✉) • C. Steiger
SAP Digital Business Services (DBS), SAP Deutschland SE & Co. KG, resp. SAP SE, Walldorf, Germany
e-mail: edward.schreckling@sap.com; christoph.steiger@sap.com

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The same view can be derived from the answers of about eight hundred leading experts and executives from the information and communications technology (ICT) sector to the World Economic Forum's Global Agenda Council on the Future of Software & Society's request for their views on 21 tipping points (Thomson 2016; World Economic Forum's Global Agenda Council on the Future of Software & Society 2015). The interviewees identified 13 signs that a fourth industrial revolution might be around the corner:

1. Implantable and wearable technologies.
2. Our digital presence.
3. Vision as the new interface.
4. Ubiquitous computing.
5. A supercomputer in your pocket.
6. Storage for all.
7. The internet of and for things.
8. Smart cities and smarter homes.
9. Big data for big insights.
10. Robots, decision-making and the world of work.
11. The rise of digital currencies.
12. The sharing economy.
13. 3D printing.

Schwab contends that these and other physical, digital, and biological megatrends will fundamentally alter the way we live, work, do business, and relate to one another: "In its scale, scope and complexity, what I consider to be the fourth industrial revolution is unlike anything humankind has experienced before." (Schwab 2016a, p. 1).

Independent of the questions concerning whether those megatrends indicate a fourth industrial revolution (or just a part of the third one) and when this revolution will occur, one thing is clear: 'digitization' or 'to digitize', defined as the process of changing from analog to digital form (Gartner n.d.a),[2] is not an entirely new phenomenon,[3] and it already significantly affects businesses, the economy, individuals, and society as a whole. According to a recent McKinsey study, digitization now touches most Americans and most of the US economy (Manyika et al. 2015a); in fact, "the effects of an increasingly digitized world are now reaching into every corner of our lives." (Friedrich et al. 2011, p. 3). (We explicitly differentiate between 'digitization' or 'to digitize' and 'digitalization' or 'to digitalize'.[4])

[2] An example of digitization in this sense is the conversion of an analog audio signal into digital music.

[3] Early examples include Electronic Data Interchange (EDI), which started in the 1960s; the Internet, used by the general population since the 1990s; and e-commerce, first promoted around the year 2000.

[4] See Sect. 2.

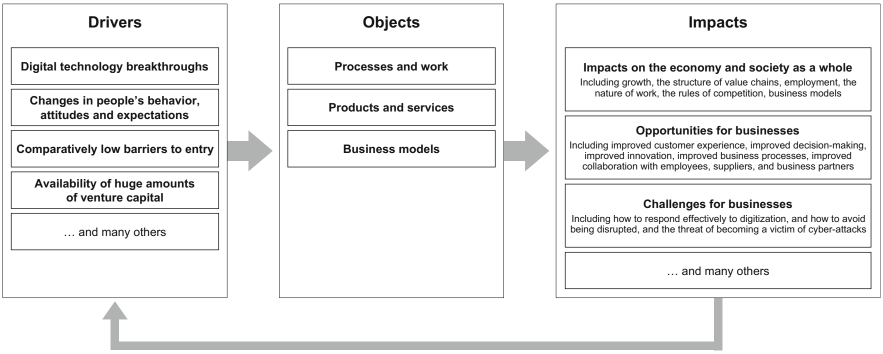

Fig. 1 Drivers, objects, and impacts of digitization

However, from the perspective of businesses, which have been digitizing for decades (by for instance, implementing standard software to digitize business processes), the question arises concerning why the current wave of digitization is new or different from those before. To answer this question, it is helpful to cast a glance at the drivers, objects, and impacts of digitization, and how they relate to each other (see Fig. 1).

1.1 Drivers of Digitization

Drivers of digitization include digital technology breakthroughs; changes in people's behavior, attitudes and expectations; comparatively low barriers to entry; and the availability of huge amounts of venture capital[5] (see left section of Fig. 1). These four driving forces act in concert and powerfully reinforce one another.

Digitization is mainly driven and enabled by digital technology breakthroughs like (s)ocial media, (m)obile computing, (a)nalytics/big data, (c)loud computing (SMAC; a.k.a. 'third platform'), the Internet of Things (IoT), cyber-physical systems (CPS), cyber-human systems (CHS), and cyber-security (SAP 2015; Kowalkiewicz et al. 2016).[6] Digital technologies have a wide reach and their dissemination is increasingly fast (Dreischmeier et al. 2015; Ernst & Young 2011). The underlying causes of this increasing dissemination are Moore's law[7] and Metcalf's law:[8] "Computing hardware becomes ever more powerful, small, and

[5]This enumeration of drivers is not exhaustive. For more drivers (e.g., demographic shifts, greater urbanization), see Toner et al. (2015), p. 2, Fig. 1, and Friedrich et al. (2011), p. 16, Exhibit 7.

[6]This enumeration of digital technologies is neither mutually exclusive nor exhaustive.

[7]Moore's law is the observation that the number of transistors in a dense integrated circuit doubles approximately every two years; see https://en.wikipedia.org/wiki/Moore%27s_law

[8]Metcalfe's law states that the value of a telecommunications network is proportional to the square of the number of connected users of the system; see https://en.wikipedia.org/wiki/Metcalfe%27s_law

thus embedded and ubiquitous. Simultaneously, network effects lead to a superlinear [sic!] increase in value by connecting systems, processes, and users." (Gimpel and Röglinger 2015, p. 6).

That digital technologies are evolving at an exponential, rather than linear, pace provides a first answer to the question concerning why the current wave of digitization differs from those that came before.

A breeding ground for the fast and wide diffusion of digital technologies are the changes in people's behavior, attitudes, and expectations, particularly the speed with which people adopt new technologies, what we want our environments to be like, and how we communicate with one another, plan our actions, prepare our decisions, share our experience and impressions, buy and sell, and the way we want our work environment to be like. These changes act as a second driver of digitization (Berman and Bell 2011) and are closely related to the first driver of fast and wide dissemination. Today's users adopt new technology much more quickly than ever before. For example, while it took 38 years for the radio to reach 50 million people, Angry Birds took just 35 days (Frey and Osborne 2015). WhatsApp gained more followers (700 million) in its 6 years of existence than Christianity did in its first nineteen centuries (Anders 2015).

Today, people who use technology expect to have access to everything all the time from any device anywhere in the world for all kinds of purposes. Google has identified four 'micro-moments' when we turn to a connected device—often a smart phone—to take action on whatever we need or want right now. These four kinds of micro-moments are loaded with intent, context, and immediacy (Adams et al. 2015):

1. I-want-to-know.
2. I-want-to-go.
3. I-want-to-do.
4. I-want-to-buy.

Eighty-seven percent of young people in the US say their smart phone never leaves their side, and 44 % use their camera function daily (Mitek & Zogby Analytics 2014). The number of connected devices will rise to 25 billion by 2020 (Gartner 2014) and will far exceed the number of people in the world. As of April 2016, there were 7.4 billion people on the planet, of whom 6 billion have access to mobile phones—while only 4.5 billion have access to working toilets (Wang 2013). IP-enabled sensors are projected to exceed 50 billion by 2020 (Evans and Forth 2015). Thirty billion WhatsApp messages are sent every day (Kokalitcheva 2015). Mobile broadband subscriptions reached 2.5 billion in 2014, five times the number in 2008 (Evans and Forth 2015). Mobile data traffic has grown by a factor of four thousand over the past 10 years and by a factor of almost 400 million over the past 15 years (Cisco 2016). The world's stock of available data is expected to double every 2 years; 99 % of it is digitized, and over half has an IP address (Evans and

Forth 2015). One could easily agree with Jerry Dischler, VP of AdWords Product Management at Google, in saying, "We're not going online, we're living online." (Kim 2015).

People's insistence on being connected is transforming their personal lives, and their willingness to share everything is changing long-held attitudes about privacy (Friedrich et al. 2011). Consumers' habits like seeking information and advice via digital devices and social networks before making a purchase mean that customers are 'always on', companies can interact with them at any time, and companies are constantly in the business of creating 'content' (information about products and services). Customers have been spoiled by companies like Amazon and Apple and now expect every organization to deliver products and services swiftly, with a seamless user experience that offers intuitive interfaces, around-the-clock availability, real-time fulfillment, personalized treatment, global consistency, and zero errors (Markovitch and Willmott 2014).

Changes in people's behavior, attitudes, and expectations also force companies to rethink how to attract, treat, and retain their employees. Members of the new generations—call them Generation Y or Generation C—not only expect to live their digital lives at work but desire transparency, authenticity, personal engagement, and, above all, contemporary corporate and political models (Ernst & Young 2011; Friedrich et al. 2011). What they want is "transformational change, and where they cannot find it, they look to invent it themselves." (Ernst & Young 2011, p. 5).

The concept of 'inventing it themselves' leads over to a third driver of digitization: the comparatively low barriers to entry that allow anyone with an internet connection and a great idea to become an entrepreneur, even with limited capital (Manyika et al. 2015a; Hirt and Willmott 2014). As a result, innovative competitors emerge from unexpected places and quickly overtake well-established incumbents by accessing global digital platforms for research, development, marketing, sales and distribution and by improving the quality, speed, and price at which they deliver value. Prominent examples include the largest taxi company in the world, which owns no vehicles; the most popular media owner in the world, which creates no content; the most valuable retailer in the world, which has no inventory; and the largest provider of overnight accommodations in the world, which owns no real estate—Uber, Facebook, Alibaba, and Airbnb (Goodwin 2015).

The start-up capital that is required to develop a great idea into an innovative product or service and bring it to market points to the fourth driver of digitization: the huge amount of venture capital that is available from investors who are looking for profitable opportunities outside the old economy (see Fig. 2).

In 2015 venture capital in the digital economy exceeded $32 billion worldwide—$23 billion in e-commerce, $7.3 billion in financial technology, $1.3 billion in the IoT, $492 million in virtual reality, and $418 million in drones (Raconteur n.d.).[9]

[9]For digital investment predictions for 2016, see Raconteur (2016a).

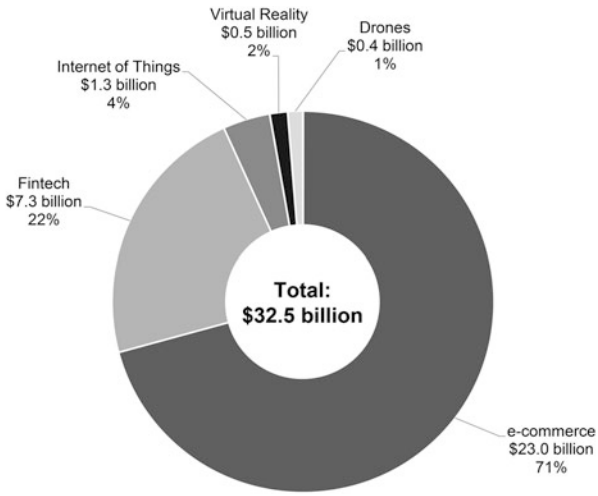

Fig. 2 Venture capital in the digital economy 2015 (Raconteur n.d.)

A startup has a 1.28 % chance of becoming a 'unicorn' company—a private company valued at $1 billion or more based on fundraising (CB Insights 2016). Unicorns are increasing rapidly: in 2013 sixteen unicorns were born, while 38 emerged in 2014 and 68 in 2015 (CB Insights 2016). As of April 2016, there were 153 unicorn companies globally.[10]

1.2 Objects of Digitization

Objects of digitization are processes and work; products and services; and business models (see the middle section of Fig. 1).[11] To digitize in this context also means connecting people and things, including assets and material.

Processes and work have been the objects of digitization for decades. While digitization once mainly concerned data management and processing in companies' IT departments, it now affects all departments and has moved from administrative and support tasks to core business processes (Gimpel and Röglinger 2015). Today, companies go far beyond simply automating existing processes. To meet the increased customer expectations, they often reinvent entire business processes, challenging everything related to an existing process and rebuilding it using cutting-edge digital technology (Markovitch and Willmott 2014). The grocery chain Tesco provides an example of the digitization of an entire business process:[12]

[10]For details, see https://www.cbinsights.com/research-unicorn-companies (updated in real time).

[11]This enumeration of objects of digitization is not mutually exclusive. For instance, products and services are part of the value proposition, which is a building block of a business model (Osterwalder and Pigneur 2010). Subsuming assets and materials under the category of processes and work renders the enumeration exhaustive.

[12]See the instructive video at https://www.youtube.com/watch?v=fGaVFRzTTP4

When Tesco wanted to expand its market share in South Korea, they imagined and realized a digitized process to sell their products without building new stores by using its subsidiary Homeplus to put up posters in subway stations with their range of products, accompanied by Quick Response (QR) codes. This approach is especially appropriate because many people in South Korea work long hours and commute. Once the posters were up, all customers had to do was scan the QR codes of the desired products with their smart phones, and the groceries were delivered to their doorsteps when they got home. Holland's government provides another example (Cisco 2012): to meet changed employee expectations, the City of Amsterdam provided a secure wireless network throughout and around government agency buildings that allowed its 1600 employees to use any device anywhere to access the data and information they needed to do their jobs. At the same time, the government reduced its IT costs by eliminating the use of external telecom providers.

Digitization of products and services is not binary—not just traditional/physical or digital; it moves on a continuum from primarily physical to primarily digital, mixing digital and physical along the way (Berman and Bell 2011, especially Fig. 2 on p. 4). Beginning in the 1990s, in a few industries, such as music, entertainment, and electronics (Berman and Bell 2011, especially Fig. 1 on p. 2), the drivers of digitization pushed all industries toward the digital end of the physical-digital continuum. Because of the availability of smaller, smarter, and cheaper sensors (i.e., transmitters and radio frequency identification (RFID) tags), almost any physical product, work piece, asset, package, pallet, container, transport vehicle, garment, accessory, and even human body can now be equipped with electronic tags, allowing a company to, for instance, track where a physical product is as it moves through the supply chain, how it is performing, and how it is being used. Similarly, customers can, for instance, track (almost in real time) the progress of a package they are expecting or the condition of a machine in a manufacturing process. In addition to (or instead of) so-called smart products, an integration of physical products with digital innovations allows companies to design 'smart' services that are based on or enabled through digital technologies, including "new solutions that extend existing service offerings, digital services that enrich physical products, [and] hybrid product-service bundles." (Gimpel and Röglinger 2015, p. 11). Three examples from different markets and industries illustrate this digitization of products and services.

Runtastic offers a combination heart-rate monitor and scale with which runners can transfer their data via Bluetooth to Runtastic's smartphone app and upload it via the internet to Runtastic's platform, where it can be analyzed and shared with other members of the fitness community.[13]

Hagleitner equipped its dispensers with an integrated radio frequency system that counts every soap, disinfectant, and towel release.[14] Information like the

[13]For details, visit https://www.runtastic.com

[14]See the instructive video on https://www.youtube.com/watch?v=kFuyzLF5Vew

number of entrances into a washroom, dispenser fill levels, battery status, and the number of disposals is sent to a web-based central site, where it is available to the facility managers. Hagleitner's customers can analyze the data about user behavior in their washrooms (enabled by the SAP HANA® Cloud Platform), check the status of every dispenser with any web-enabled device (computer, tablet or smartphone) anywhere and at any time. Individualized cleaning schedules and routes for cleaning staff can be arranged, along with just-in-time deliveries, as the system facilitates predictive planning, thereby reducing inventory and storage costs.

SAP's Asset Intelligence Network (AIN),[15] a cloud-based central repository that OEMs, operators, and service providers can leverage to upload, collect, track, and trace equipment information, facilitates collaborative asset management and lets members take advantage of the IoT. Operators can access current maintenance strategies, manuals, and more from manufacturers, who upload 'digital twins' of their products. Operators benefit from complete asset information, tailored services, and fewer maintenance issues, while manufacturers can automatically receive data about asset usage and failure from operators to improve their products. According to IDC, 75 % of the Global 2000 will have developed full information-based economic models, or 'digital twins', of their products/services, supply networks, sales channels, and operations by 2018 (Anderson et al. 2015). Clearly, digitization of products and services can increase their value.

The third object of digitization is business models. The examples given above show that the boundaries between the digitization of products and services and the digitization of business models are blurred. This blurring occurs because the bundle of products and services that create value for a specific customer segment describe the value proposition that is a building block of a business model (Osterwalder and Pigneur 2010).[16]

For example, a Runtastic premium membership includes free training plans, advanced statistics and analysis, a weekly fitness report, records and personal bests, personal cheers, premium support, and no ads. As for Hagleitner, it could switch from fixed pricing for their products to usage fees (pay per use or entry), thereby changing its business model (building block: revenue streams). Such business models, which sell solutions and results rather than just products and services, are typical for the 'outcome' economy, defined by companies' ability "to create value by delivering solutions to customers that … lead to quantifiable results." (Daugherty et al. 2015, p. 37).

Another typical hotbed of new digital business models is the platform economy, where "others outside the company are creating value—in many cases enabling

[15]See the instructive video on https://www.youtube.com/watch?v=omKJmPpL6Zs

[16]According to this concept, the other building blocks are customer segments, channels, customer relationships, key resources, key activities, key partners, revenue streams, and cost structure. For a description of the prominent (digital) business models of Amazon, Netflix, LinkedIn, and Airbnb according to this concept, enhanced with so-called digital value drivers (people, businesses, things, data, cloud), see SAP (2016). For more business models, see Gassmann et al. (2014).

entirely new digital models for the company." (Daugherty et al. 2015, p. 53). Examples are Apple's App Store, Alibaba, eBay, PayPal, Facebook, and SAP's YAAS. YAAS, SAP hybris® service cloud platform, is a marketplace for utilities and services around customer engagement, commerce, and other businesses[17] that is open to businesses and developers. For instance, enterprises can quickly add new business capabilities to their existing applications by subscribing to application programming interfaces (APIs), the 'secret sauce' of the digital economy. Platform ecosystems play a strategic role in all types of businesses: asset-heavy businesses like GE and Philips, asset-light businesses like Google and Uber, and mixed systems like Apple and Amazon that have powerful platform ecosystems combined with asset-driven businesses (Daugherty et al. 2015).

These brief descriptions of the objects of digitization show that digital technologies have significantly expanded the possibilities for companies across all markets and industries to re-imagine their main levers, from processes and work via products and services to entire business models. Digitization now changes both 'the how' and 'the what', and there is no limit: everything that can be digitized will be digitized (Negroponte 1995),[18] and everything that can be connected will be connected (Morgan 2014).

The unparalleled increase in the breadth and depth of digitization is the second answer to why the current wave of digitization differs from those that preceded it.

1.3 Impacts of Digitization

The impacts of digitization include large and varied impacts on the economy and society as a whole, extraordinary opportunities, and significant challenges for businesses (see the right section of Fig. 1).[19]

Digitization heavily impacts the economy and society as a whole and in a variety of dimensions, including growth, business models, industry landscapes, the structure of value chains, investment, productivity, consumption, employment, skills, the nature of work, the rules of competition, and how business is conducted (Hirt and Willmott 2014; Schwab 2016a). We'll highlight a few of these impacts in more detail.

According to Accenture's Digital Economic Value Index, the growth of the digital economy has put it on course to account for 25 % of the world's economy by 2020, up from 15 % in 2005 (Daugherty et al. 2016). According to a recent analysis by McKinsey's Global Institute, by 2025 three effects of digitization alone—

[17] For details, visit https://www.yaas.io/

[18] When redesigning its branding in the 1990s, Razorfish included the slogan, "Everything that can be digital will be." See https://en.wikipedia.org/wiki/Razorfish_(company)

[19] This enumeration of impacts of digitization is not exhaustive, as it focuses on impacts for businesses. Impacts on individuals and society as a whole are not less massive or less varied.

increased labor supply and productivity, improved asset efficiency, and multi-factor productivity, especially in operations and supply chain optimization—could boost the US's annual GDP by up to $2.2 trillion (Manyika et al. 2015a). The same institute estimates that the IoT has a potential annual economic impact of $3.9–11.1 trillion in 2025 (Manyika et al. 2015b).

Digitization's lowering of entry barriers, in addition to allowing competitors to emerge from unexpected places and paving the way for new business models to evolve quickly often causes value chains to disaggregate, long-established boundaries between sectors to tumble, and occasionally entirely new industries to emerge (Hirt and Willmott 2014). For example, the platform business models are a fast-increasing part of the digital economy. The top 15 public platform companies—Alibaba, Alphabet, Amazon.com, Apple, Baidu, eBay, Facebook, JD.com, LinkedIn, Netflix, Priceline.com, Salesforce, Tencent, Twitter, and Yahoo!—already represent $2.6 trillion in market capitalization worldwide (Daugherty et al. 2016).

Further impacts of digitization include new pressure on prices and margins, winner-take-all dynamics, plug-and-play business models, talent mismatches, converging global supply and demand (Hirt and Willmott 2014), shifting customer expectations, increasing collaborative innovation (Schwab 2016a), and new institutional options with distinct economics (Evans and Forth 2015). An example of new business rules is the distribution power law, which relates to the platform business models' enabling scale "by allowing others to generate profits in the 'long tail' of the distribution curve—avoiding diminishing returns associated with traditional (linear) value chain models." (Daugherty et al. 2016, p. 41).

Digitization impacts all geographies, industries, and companies, although different geographies, industries, and companies experience digitization at different speeds (Opitz et al. 2015; Berman and Bell 2011; Friedrich et al. 2011; Daugherty et al. 2016). Every industry is going through a digital transformation, "some crisis-induced, some as part of their core strategy, and some as part of a more controlled transition process." (Bonnet and Nandan 2011, p. 4). According to Daugherty et al., "Every business is now a digital business." (Daugherty et al. 2013, p. 4).[20]

That the degree of digitization's economic impact has developed from 'limited' to 'pervasive' is the third answer to why the current wave of digitization is different from those that came before.

The digital forces at work today bring huge opportunities, challenges—or both—to all businesses. Hence, digital capabilities increasingly determine whether a company creates or loses value (Hirt and Willmott 2014). Few companies need to be sold on the benefits of digitization (Desmet et al. 2015), as every business understands its transformational power (Daugherty et al. 2016). The opportunities digitization offers include improved customer experience and engagement, improved decision-making (based on big data and advanced analytics), improved innovation (of business models, products, and services), improved and/or

[20]For examples, see SAP (2015).

automated business processes, and improved engagement by and collaboration with employees, suppliers, and business partners (McKinsey & Company 2015; Fitzgerald et al. 2013; Desmet et al. 2015; Kane et al. 2015; Catlin et al. 2015; Hirt and Willmott 2014).

Seizing these and other opportunities can benefit key performance indicators like cost, revenue, profit, return on invested capital, customer and employee satisfaction, and market valuation. For example, Spirit AeroSystems, one of the largest non-OEM designers and manufacturers of structures for commercial, military, and business/regional jets in the world, obtained more current information by implementing in-memory computing based on SAP HANA.[21] Spirit is now able to get real-time insight into costs, which allows them to improve how they allocate their human resources and has reduced overtime by 40 % in some areas. Once Spirit has implemented the technology in all of its assembly areas, it expects reductions of up to 25 % in production flow times and up to 30 % in assembly inventory levels.

McKinsey research shows that companies expect digital initiatives to deliver annual growth and cost efficiencies of 5–10 % or more in the next 3–5 years (Catlin et al. 2015). The 153 unicorn companies alone, which include companies like Uber, Xiaomi, Airbnb, Palantir Technologies, China Internet Plus Holding, Snapchat, and WeWork (CB Insights 2016), represent around $500 billion in market capitalization worldwide (Daugherty et al. 2016). Almost a third of the European unicorns are financial technology companies (CB Insights 2016).

The other side of the coin is that digitization brings with it significant challenges for businesses. Most of these challenges can be subsumed under the overarching question concerning how to respond effectively to digitization or, with regard to digitization's biggest threat, how to avoid being disrupted.[22] As we will discuss these questions in more detail later,[23] it is sufficient to take a look at the challenges and the main threat in general here.

Digitization can impact all of a company's levers and change the entire business environment. Therefore, companies must address all implications of a digital change, re-imagine all aspects of their business, and develop coherent end-to-end responses and transform appropriately (Ernst & Young 2011). Companies that ignore digitization are likely to lose relevance and even to fail. This peril particularly concerns well-established companies that are not primarily structured around or operating in the digital economy (and so do not have native digital structures), yet whose future depends heavily on successful digital innovation and transformation (Gimpel and Röglinger 2015). The CEOs of these companies have an unambiguous choice: "invest now in the internal and external digital capabilities their

[21]For details, see https://ideas.sap.com/D16183

[22]Christensen coined the term "disruptive innovation" to describe how new entrants target the bottom of a market and then relentlessly move up-market, eventually ousting established providers (Christensen 1997).

[23]See the nine dimensions of the digital innovation and transformation framework we propose below.

companies will need to differentiate themselves from the competition. Or sit back, watch the digital revolution unfold, and run the risk of being outflanked by more forward-thinking, faster-moving rivals." (Friedrich et al. 2011, p. 3). These new intruders, often powerful, native digital companies, can either come from the incumbent's industry or from other industries (IBM 2015). Recent history is replete with examples of organizations that have not been able to keep pace with new realities (Bonnet and Nandan 2011), such as the movie rental company Blockbuster, which went into bankruptcy with the rise of Netflix.[24] At the current rate, 75 % of S&P 500 incumbents will be gone by 2027 (Capozzi et al. 2014). Digitization can even disrupt entire industries when it changes the nature of supply, demand, or both (Dawson et al. 2016). Therefore, all industries and companies must no longer consider whether they are going to be disrupted but when, what it will look like, and how it will affect their organizations (Schwab 2016a).

Another challenge for businesses in the digital economy is the omnipresent threat of becoming a victim of cyber-attacks (Raconteur 2016b).

The impacts of digitization—enormous and varied impacts on the economy as a whole, extraordinary opportunities, and significant challenges for businesses—retroact on digitization as drivers (see Fig. 1). Thus, digitization becomes a self-perpetuating process.

The answers to the question concerning why the current wave of digitization different from previous changes relate to its historic size, speed, and scope (Schwab 2016a, with regard to the fourth industrial revolution), its inevitability, irreversibility, uncertainty in execution (Krcmar 2015), and ubiquity.

2 Digitalization: Digital Innovation and Transformation

For businesses the only reasonable reaction to persistent digitization is digitalization. 'Digitalization' or 'to digitalize' can be defined as "the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business." (Gartner n.d.b). A digital business can be defined as one that creates "new business designs by blurring the digital and physical worlds." (Lopez 2014) or as a business in which value creation is significantly based on digital technologies. In the course of digitalization, companies might even have to disrupt their own business models and markets before others do by coming up with the digital innovations necessary to survive in the digital race (Daugherty et al. 2016; Ernst & Young 2011; Desmet et al. 2015). Digitalization in this sense is often referred to as 'digital transformation', wording that we contend falls short of the mark because it only implicitly reflects the key innovation part; innovation and transformation are both required to generate value

[24]For a brief review, see Satell (2014).

in the digital economy. Therefore, we refer to 'digital innovation and transformation' or 'digitalization'.

Given digitization's characteristics and impacts, digitalization is no longer a choice but an imperative (Dreischmeier et al. 2015); for all businesses across all industries and regions the motto is digitalize or drown.

2.1 Strategic Questions and Mistakes

When embarking on a journey of digitalization, business executives have strategic questions like:

1. Who are our competitors in the digital economy?
2. How fast must we act?
3. What is the value of digitalization for our business?
4. What capabilities do we need in the digital age?
5. How does digitalization affect my existing customers?

At the same time, we see widespread strategic mistakes that business executives make in the digital economy, including:

1. Confusing digital business with online selling.
2. Digitizing the as-is state but failing to re-imagine their existing business model (s).
3. Refraining from leveraging data to improve their understanding of their customers' needs.
4. Waiting instead of acting.

Our general strategic advice for business executives includes:

1. Understand and evaluate digital opportunities, select the best choice, and allocate substantial resources.
2. Establish an agile culture (make quick decisions, establish a robust operating model).
3. Get the right digital capabilities in place, including:
   (a) Leveraging big data and advanced analytics to improve customer insights and derive new offerings that meet the customer demand.
   (b) Digitizing the core processes to accelerate and simplify business and reduce operating costs.
   (c) Developing the ability to connect with customers, suppliers, and business partners easily.
   (d) Establishing a two-speed IT to ensure that IT is both operated efficiently and capable of enabling innovation.
   (e) Building strong alliances and partnerships (and, if necessary, even with competitors).

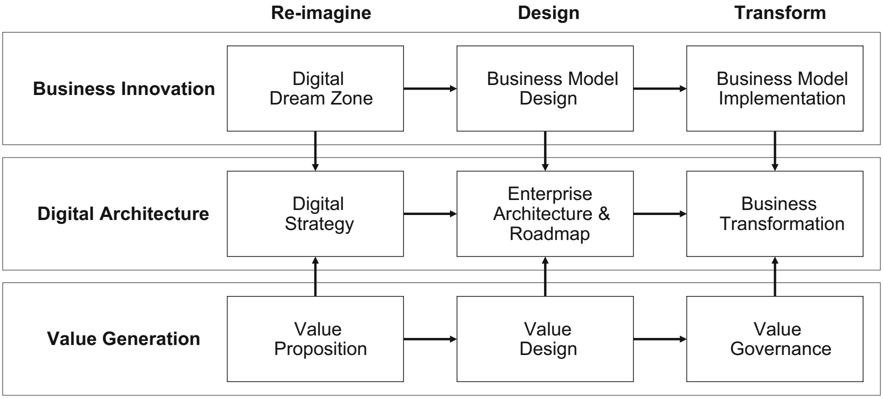

Fig. 3 Digital service portfolio

2.2 Digital Service Portfolio

Independent of where a business's customers stand and what they want to achieve, we can accompany them on their entire digitalization journey by providing them with appropriate services at every stage of the journey. Our digital service portfolio has three layers—business innovation, digital architecture, and value generation—and three phases—re-imagine, design, and transform. These layers and phases result in a matrix with nine boxes (see Fig. 3).

Each box is comprised of several services that build on a proven technique or methodology and that can be tailored to industry- and customer-specific features. The business innovation layer contains services with which our customers can re-imagine and implement new digital business models or digitize their processes and work environments, leveraging techniques and methodologies like Design Thinking[25] and Digital Business Modeling (SAP 2016). The services in the digital architecture layer focus on designing and realizing the appropriate technology foundation for the digital business, delivering outcomes like a target enterprise architecture, transformation roadmap, and an organizational change management concept. The complementary value generation layer is comprised of services like business cases and dashboards with value-related key performance indicators that ensure that our customers realize value from digitalization.

[25]For more information, visit http://scn.sap.com/community/design-thinking

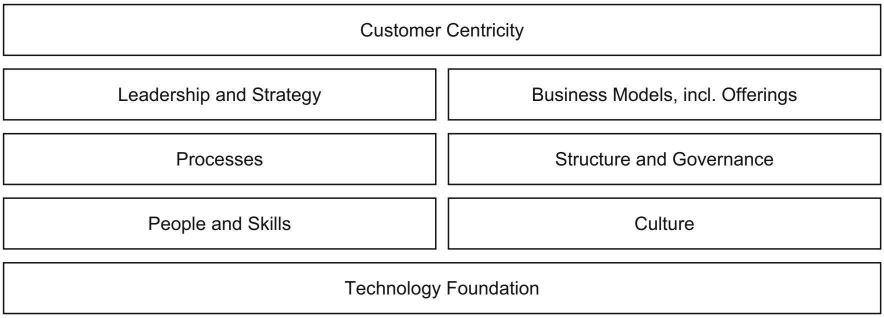

Fig. 4 Digital innovation and transformation framework

2.3 Digital Innovation and Transformation Framework

All nine boxes of our digital service portfolio leverage our digital innovation and transformation framework, particularly when we are assessing our customers' digital capabilities and developing a comprehensive digital strategy with them.[26] The framework has eight dimensions that we believe are key to successful digitalization (see Fig. 4).[27]

2.3.1 Customer Centricity

Customers are the main beneficiaries of digitization, so their expectations are among its drivers (see Sect. 1.1). Therefore, under the heading of customer centricity, we engage our customers in an open discussion on several questions, among which are these ten:

1. What are the expectations and preferences of our customers across all segments and markets, and how are we engaging with them to understand their needs and expectations?
2. Which customer journeys matter, and how and why do our customers make decisions?
3. How are our customers changing in the digital environment?
4. Is customer value at the center of our corporate strategy and business models?
5. Are we driving customer centricity into each part of our enterprise and using social networking tools and capabilities to engage them (customer and community collaboration)?

[26]We developed this framework together with SAP's CIO Center for Digital Leadership, considering existing frameworks such as those outlined in Gimpel and Röglinger (2015), Wade (2015), and Desmet et al. (2015).

[27]The framework is neither mutually exclusive nor exhaustive.

6. What are we doing to make sure we always put our customers at the center of our supply chain planning and execution?
7. How can we respond dynamically to customer usage and feedback in near-real-time?
8. Are we integrating all customer touch-points across digital and physical channels (web, mobile, mail, face-to-face)?
9. How can we develop an omni-channel view of circular customer journeys and align metrics against top journeys?
10. How do we find out how segment value and satisfaction varies in order to focus on elements that will move the needle? (Berman and Bell 2011; Desmet et al. 2015; Dörner and Meffert 2015; Dreischmeier et al. 2015; Wade 2015; Xu 2014).

2.3.2 Leadership and Strategy

Leadership and strategy are key to successful digitalization, but businesses often fail to give them sufficient consideration. Therefore, under the heading of leadership and strategy, we encourage our customers to discuss several topics with us, among which are these ten:

1. Have we integrated digitization and digitalization into all elements of our strategic planning (e.g., do we continuously analyze our markets with regard to new competitors, new digitized products and services, and new digital business models)?
2. How well do we know where change is occurring and where digitization is having the greatest impact?
3. Is digitalization on top of our strategic agenda and at the center of our corporate strategy?
4. Have we created an according sense of urgency in our company and communicated a clear vision?
5. Should we diversify or double down on digital initiatives?
6. What is the focus of our digital initiatives? (Improved customer experience and engagement? Improved decision-making? Improved innovation? Improved and/or automated business processes? Improved engagement of and collaboration with employees, suppliers, and business partners?).
7. Do we plan and track the value of our digitalization initiatives and fund them appropriately?
8. How do we position our business in the broader ecosystem (the network of companies, individual contributors, institutions, and customers that interact to create mutual value)? For instance, what is our co-innovation strategy?
9. Do we keep our digital businesses separate or do we integrate them into our current non-digital businesses?
10. Should we buy or sell businesses in our portfolio (e.g., sell non-digital businesses and buy digital businesses)? (Xu 2014; Desmet et al. 2015; Dreischmeier et al. 2015; Dörner and Meffert 2015).

2.3.3 Business Models, Including Offerings

Both business models and offerings (products and services) are objects of digitization (see Sect. 1.2). Therefore, under the heading of business models, including offerings (products and services), we recommend that our customers examine their answers to several questions, among which are these ten:

1. Do we constantly scrutinize and re-imagine our existing business models?
2. What kind of digital business models have our competitors developed and implemented?
3. Have we tried to disrupt our own business models (before others do)?
4. How can we digitize and connect our (tangible) products (e.g., by adding sensors)?
5. How can we extend our portfolio by designing smart services that enrich physical products?
6. Have we recently performed a granular diagnostic of value creation/destruction across our business models and value chain?
7. How can we reshape the customer-value proposition of our offerings by digitizing them?
8. How can we leverage our data more effectively?
9. Can we generate revenues directly from our data?
10. Should we run scenario testing to test (and flip) various business-model assumptions and industry trends? (SAP 2016; Xu 2014; Fitzgerald et al. 2013; Kane et al. 2015; Hirt and Willmott 2014; Berman and Bell 2011; Gimpel and Röglinger 2015; Dreischmeier et al. 2015; Wade 2015; Desmet et al. 2015; Daugherty et al. 2016).

2.3.4 Processes

Processes are among the objects of digitization (see Sect. 1.2). Under the heading of processes, we advise our customers regarding the many opportunities and challenges they face in digitizing processes, among which are these ten:

1. To what extent are our core business processes already digitized, and is there still untapped potential? (Are our core processes leveraging the scale- and speed-related benefits of digitization?).
2. How can we use process automation to reduce costs and improve customer experience?
3. How can we rapidly digitize series of small or midsize processes?
4. How can we remove obstacles (e.g., silos) on the way to digitized end-to-end processes?
5. How are we realizing the benefits of open collaboration with our customers and business partners?
6. Are we optimizing all elements of our supply chain, effectively integrating them across the enterprise (i.e., a digitally enabled supply chain)?

7. Are we integrating information across all sources, internal and external, and taking full advantage of the predictive power of big data and advanced analytics (insights from analytics)?
8. Do we have processes and techniques in place that foster digital innovation?
9. Do we have a disciplined 'test and learn' approach?
10. Do we have appropriate methods and tools that ensure the successful management of our digital transformation projects and initiatives (e.g., our SAP BTS Business Transformation Management Methodology)? (Xu 2014; Fitzgerald et al. 2013; Kane et al. 2015; Hirt and Willmott 2014; Berman and Bell 2011; Gimpel and Röglinger 2015; Cigaina 2013; Wade 2015; Desmet et al. 2015).

2.3.5 Structure and Governance

Structure and governance are the organizational counterparts of processes, so they play an important role in digitalization journeys. Therefore, under the heading of structure and governance, we engage in open discussions with our customers related questions, among which are these ten:

1. Do we run our digital initiatives separately or are they fully integrated into our corporate organization?
2. Do we have appropriate structures and governance mechanisms in place that facilitate digital innovation and transformation (e.g., non-hierarchical organization, few silos, high organizational permeability, high level of cross-department collaboration)?
3. Have we established dedicated senior positions (e.g., a chief digital officer) and other management roles with corresponding tasks and responsibilities to lead cross-functional teams and execute our digital initiatives?
4. Are our employees empowered to act and break through problems?
5. Do we have appropriate key performance indicators, incentives, and compensation models in place that foster digital innovation and transformation?
6. Do we manage our budget for digitalization using a multi-year horizon across functions and initiatives?
7. How do we switch from investments fixed to budget cycles to investments linked with top progress?
8. Do we have mechanisms in place with which to challenge ideas (e.g., challenger or advisory boards)?
9. How do we transform from functional silos to agile organizational structures in which small teams can collaborate across functions?
10. How do we change our current focus on operational tasks to planning, exception-handling, analysis, and coordination? (Xu 2014; Fitzgerald et al. 2013; Krcmar 2015; Kane et al. 2015; Hirt and Willmott 2014; Berman and Bell 2011; Gimpel and Röglinger 2015; Cigaina 2013; Daugherty et al. 2016; Dreischmeier et al. 2015; Dörner and Meffert 2015; Wade 2015; Desmet et al. 2015).

2.3.6 People and Skills

Managers and employees and their skills can present a high hurdle across the road to a digital business. Under the heading of people and skills, we encourage our customers to discuss with us these ten topics, among others:

1. Do we know our employees' attitudes and expectations about their work environment and personal development (e.g., transparency, authenticity, desired career paths)?
2. What new skills and competencies are required in the digital world?
3. How digitally savvy are our leaders and employees?
4. Do our leaders have the skills and competencies that facilitate digitization (e.g., commitment to digital technologies and the ability to explore options, choose the right direction, share vision, set appropriate goals, create feasible roadmaps, make quick decisions, reward success appropriately, act 'value in use', live 'exploit and explore')?
5. Do our employees have the right skills and competencies to facilitate digitization (e.g., strong business acumen, interdisciplinary thinking and action, ability to deal with complexity and increased speed of innovation, resilience, skills in mobile applications and advanced predictive analytics, familiarity with techniques and methodologies like Design Thinking and Digital Business Modeling)?
6. How and from where do we recruit people with the required skills and competencies?
7. How do we attract digital talent, and what can we offer them?
8. What are suitable strategies and programs with which to develop digitalization skills and competencies?
9. How do we retain staff with digital expertise and skills?
10. How can we improve the work environment for our employees (e.g., through applications with superior user experience)? (Xu 2014; Fitzgerald et al. 2013; Krcmar 2015; Kane et al. 2015; Hirt and Willmott 2014; Berman and Bell 2011; Gimpel and Röglinger 2015; Daugherty et al. 2016; Dreischmeier et al. 2015; Dörner and Meffert 2015, Wade 2015; Desmet et al. 2015).

2.3.7 Culture

Culture can be another high obstacle on the path to a digital enterprise. Therefore, under the heading of culture, we recommend that our customers examine their answers to several related questions, among which are these ten:

1. Does our current culture facilitate digitalization? (e.g., what is our degree of information transparency, knowledge-sharing, and collaboration; our speed of decision-making, embracing digital technologies and disruption; our level of impatience with the status quo and sense of urgency; our degree of focus on

innovation and exploration; our entrepreneurial attitude, adventurousness, startup atmosphere, culture of mutual commitment?).
2. Is our culture amenable to change?
3. How can we create a new corporate culture that looks at digital technology as the way to enable people to adapt and learn constantly, continually create new solutions, drive relentless change, and disrupt the status quo?
4. How do we create a startup atmosphere?
5. How do we replace information-hiding with knowledge-sharing?
6. How can we bring a prototype mentality to our organization?
7. How can we foster a service-oriented and customer-centric culture?
8. How can we establish a data-driven decision-making culture?
9. How can we create a culture of security and respect for privacy?
10. How can we build a brand that the digital community associates with creativity, entrepreneurship, and leadership? (Xu 2014; Fitzgerald et al. 2013; Kane et al. 2015; Hirt and Willmott 2014; Berman and Bell 2011; Gimpel and Röglinger 2015; Cigaina 2013; Daugherty et al. 2016; Dreischmeier et al. 2015; Dörner and Meffert 2015; Wade 2015; Desmet et al. 2015).

2.3.8 Technology Foundation

Digital technologies are among the drivers of digitization (see Sect. 1.1) and its main enabler. Therefore, under the heading of technology foundation, we help our customers answer the next ten questions, among others:

1. Do we have sufficient information on and experience with emerging digital technologies?
2. Do we have a technological infrastructure and corresponding solutions in place that enable us to digitize our core business processes efficiently (e.g., an end-to-end ERP solution)?
3. Do we have a technology foundation in place that ensures the seamless digitization of the entire customer experience (e.g., an omni-channel solution)?
4. Do we have systems, applications, and tools in place that make it easy to increase our workforce's productivity (e.g., apps that enable information access via mobile devices)?
5. Do we have a technology foundation in place that enable us to benefit from business networks and optimize collaboration with our suppliers (e.g., cloud solutions for purchasing)?
6. Do we have a technological infrastructure and corresponding solutions in place with which we can realize various IoT scenarios (e.g., tools for analyzing big data)?
7. Do we have a technological basis in place that allows us to develop, implement, and deploy innovations (e.g., new business models) effectively and efficiently?
8. Do we have all necessary systems, applications, and tools in place that can protect to the extent possible from cyber-attacks and other security risks?

9. How can we establish a two-speed IT architecture to support core functions and rapid development?
10. How can we institute continuous delivery and agile capabilities (e.g., by creating DevOps[28] teams and releasing new code within minutes)? (SAP 2015; Dörner and Meffert 2015; Wade 2015; Desmet et al. 2015).

Key Learnings

- Digitization, defined as the process of changing from analog to digital form, is inevitable, irreversible, tremendously fast, and ubiquitous.
- Drivers of digitization include digital technology breakthroughs; changes in people's behavior, attitudes and expectations; comparatively low barriers to entry; and the availability of huge amounts of venture capital.
- Objects of digitization are processes and work; products and services; and business models.
- The impacts of digitization include large and varied impacts on the economy as a whole, extraordinary opportunities, and significant challenges for businesses.
- Digitalization, defined as the process of moving to a digital business, is no longer a choice but an imperative for all businesses across all industries and regions.
- The dimensions of customer centricity; leadership and strategy; business models, including offerings (products and services); processes, structure and governance; people and skills; culture; and technology foundation can serve as orientation for digitalization.

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[28]DevOps (a clipped compound of "development" and "operations") is a culture, movement, or practice that emphasizes the collaboration and communication between software developers and other IT professionals while automating the process of software delivery and infrastructure changes; see https://en.wikipedia.org/wiki/DevOps

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Edward Schreckling is Head of Digital Thought Leadership & Enablement (DTL&E). DTL&E focuses on disseminating leading-edge knowledge on digital innovation and transformation, advancing the SAP Digital Business Services portfolio, and delivering world-class trainings for SAP DBS consultants and SAP customers. Before being appointed Head of DTL&E, Edward headed organizational development and managed strategic projects at WITTENSTEIN AG. Between 1998 and 2007, Edward worked for SAP in several positions, for instance, as Business Manager at SAP Business Consulting and Head of Strategic Projects and Operational Efficiency at SAP Service and Support. Edward studied business administration at the Technical University of Berlin and holds a doctor's degree from the University of Mannheim.

Christoph Steiger is Global Head of Business Transformation Services (BTS) at SAP Digital Business Services. SAP BTS is a global organization with a local presence in all geographies. It focuses on innovating, transforming and optimizing the business models of SAP's most strategic customers in order to maximize the return from their SAP investment. Before being appointed Global Head of SAP Business Transformation Services effective October 1, 2015, Christoph Steiger has been Head of BTS Europe, Middle East and Africa. He joined SAP early 2010 having spent 18 years in international management consulting firms such as Arthur D. Little, AlixPartners and Accenture where he was in charge of corporate and IT strategy projects, business innovation programs, merger and acquisition, as well as corporate restructuring and turnaround engagements.

The Business Consequences of a Digitally Transformed Economy

Marek Kowalkiewicz, Niz Safrudin, and Bert Schulze

Abstract The prevalence of digital technologies is forcing organizations to re-imagine the way their business models are configured, the way their business processes are designed, and the way they work in what is known today as a digital economy. While this brings a plethora of challenges due to the disruptive nature of digital technologies, the digital economy is also bringing plenty of promising opportunities for those who are aware and prepared to embrace the digital evolution. As such, it is imperative for digital enterprises to be opportunity-driven, as soon as they have identified a business problem that can be tackled. They can do so by leveraging the five emerging digitalization trends we are witnessing today, namely: (1) hyper connectivity, (2) supercomputing, (3) cloud computing, (4) smarter world, and (5) cyber security. In this chapter, we describe each trend, what it entails, and what its implications are for enterprises steering towards digitization by leveraging the five digitalization trends. We show how enterprises that benefit from these trends are able to attain not only competitive advantage through innovation, but also adapt to the changing circumstances while capturing new opportunities by means of transforming the way they run their business in the digital economy.

1 Modern Drivers of Change

It has been said that change is just a part of nature. Therefore it is natural to witness our environment changing at an unprecedented pace, particularly in what we regard today as the digital economy. Where it took years for change to happen in the past,

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M. Kowalkiewicz
Queensland University of Technology, Brisbane, QLD, Australia
e-mail: marek.kowalkiewicz@qut.edu.au

N. Safrudin (✉)
SAP (Switzerland) AG, Regensdorf, Switzerland
e-mail: norizan.safrudin@sap.com

B. Schulze
SAP SE, Walldorf, Germany
e-mail: bert.schulze@sap.com

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it can take just months or weeks today. While many argue that innovative processes have not accelerated over time, the sheer number of parallel innovative processes and their results, one after the other, creates the impression of accelerated change. The change is not coming in waves anymore, but continuously.

Fast innovators—hungry for success—disrupt established markets. Not necessarily fueled with better products, in fact some of them offering products inferior to those by incumbents, but better customer service strategies, more compelling business models or the addressing of different audiences. Smart companies leapfrog industry borders and sell additional products and services into existing markets, leaving established market leaders perplexed and behind. Due to such trends, many Tech Industry Blue Chips have become irrelevant in the course of only a decade.

A new dilemma arises once companies become market leaders: to maintain their hard-won position, they switch to defensive mode. Many innovative companies start becoming conservative the moment they become successful. They switch from an exploratory market orientation to exploitation of their respective business markets. In the short term, this helps their business position. Unfortunately, this also potentially signals the beginning of the end of their innovation leadership.

Achieving success inevitably comes with close chasers aiming to compete in the market place. They have the 'eye of the tiger', eager to take you down. Without having anything to lose competitors will gather to beat the market leader, improving and often imitating him to become better than the establishment; this is a perfectly valid market strategy. Being a close follower of the 'first mover' allows businesses to minimize risks—they only copy tested and successful business models, often focusing on markets not yet explored by the first movers. An example of such an approach is Germany's Wimdu, a business implementing the same business model that Airbnb had perfected. As of 2015, Airbnb is the world's leading accommodation provider; Wimdu is ranked sixth.

With all this pressure, the focus as market leader shifts from creating the next 'big thing' to conserving existing markets. It will maximize return on investment, thereby losing the creativity and 'eye of the tiger' that had previously propelled them to success (Christensen 1997).

A clear recommendation: *Be ready to transform while you are in shape*.

The technology foundations of the new drivers of change are catalysts for the entire industry to undergo a significant transformation. With the arrival of these technologies times are changing faster than ever, requiring companies and individuals to change and adapt. This force, once awakened, challenges many traditional markets. Some technologies slowly undermine existing standards, such as the internet did with traditional media, or others evolve into a business idea and come out unexpectedly. As an example, music streaming was illegal in the beginning. The industry tried to defend its position and banned the new technology. But once the new technology was out there, it started to disrupt other established technologies. It took a while, but today nobody has any doubts about the success of music streaming. But in both cases, big players were not prepared and now struggle to keep their territory.

Figure 1 illustrates the modern drivers of change, which include at least the following: shifting customer needs, innovation, collaboration, social and technology. Our objective in this chapter is to specifically address the changes brought about by the five key technology trends we are witnessing today: hyper connectivity, supercomputing, cloud computing, smarter world, and cyber security (SAP 2015). While these trends present an overabundance of opportunities, they are also perceived to be disruptive—as enterprises are pressured to adapt to the following challenges:

- Overwhelming complexities due to the immense connectedness in the digital economy;
- Significant pressure to provide real-time business;
- Being flexible and agile in business operations;
- Having smart decisions made to not only increase efficiency, effectiveness and agility, but also to delight the customers; and
- Establishing a trusted, safe and secure (digital) space for businesses, individuals, and society as a whole.

In the next sections, we describe in detail each technology trend, and what it means for businesses in the digital economy.

2 Hyper Connectivity

Hyper connectivity refers to the ability to connect every customer and machine at an exponential level. Hyper connectivity impacts: (a) the way people interact and consume, (b) the way businesses interact with one another, (c) the way communities engage with each other, and (d) the way sensors are used in a meaningful way. Among the prominent phenomena resulting from hyper connectivity is the Internet of Things (IoT), which is projected to have a potential economic impact of $4 trillion to $11 trillion a year in 2025, as it enables organizations and businesses to better reach new and existing customers, create new products and services, and subsequently enter new markets (McKinsey Global Institute 2015).

2.1 Attributes of a Hyper-Connected World

As every consumer and every machine ('Things') is able to be connected, all established rules around business channels are disrupted. Among the key attributes that enable hyper connectivity to exist there is the scalability of business models and processes, ubiquitous data exchange through proximity wireless technologies, as well as localization and tracking capabilities. The attributes of hyper connectivity include the following (Fredette et al. 2012):

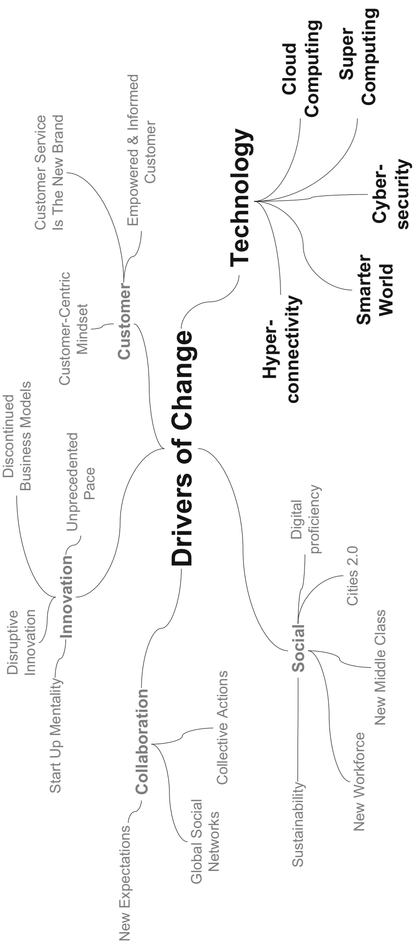

Fig. 1 Drivers of change for digital enterprises

- *Always on*: Ubiquitous mobile devices and broadband internet connections allow people to be connected 24/7, to family, friends, work, avocations, obsessions, and more.
- *Readily accessible*: A universe of mobile devices and personal computers connects people and organizations with each other, and such connections are increasingly available at any time and in any location.
- *Information rich*: 24-h access to websites, social media, search engines, news and entertainment channels and the like, ensure that information—from the strategic to the frivolous—is always accessible, beyond anyone's capacity to consume.
- *Interactive*: Anyone and everyone can offer input on just about everything.
- *Not just about people*: Hyper connectivity also includes people-to-machine and machine-to-machine communication, which supports the Internet of Things phenomenon.
- *Always recording*: Service records, practically unlimited storage capacities, miniaturized video cameras, sensors, global positioning systems, and more—combined with people's desire to document their own activities—ensure that a large portion of everyone's communications and daily activities are part of a semi-permanent record.

In short, hyper connectivity promises to be a powerful tool for collaboration that drives global alignment, increased efficiency, and material development. It opens up new channels to reach customers, and new ways to optimize assets, driving the movement of goods, services, people, knowledge and wealth.

2.2 Impact of Hyper Connectivity

Hyper connectivity does not only relate to the various means of communication and interaction, but also to its impact on behavior at both organizational and personal levels.

2.2.1 People

With a reported 3.1 billion people connected to the internet (Miniwatts Marketing Group 2014), businesses are presented with a vast market of opportunity to offer a new era of personalization. This is attributed to the connections established between people and machines, between machines and machines and between people and people, too. As a result, we are now able to observe patterns of consumer behavior among people and with machines, which in turn can provide predictive and prescriptive services.

The Internet of Things will have a potential economic impact of $4 trillion to $11 trillion a year in 2025 (McKinsey Global Institute 2015) and a sharing economy that will grow 3000 % from 2015 to 2030[1]. It is therefore no surprise that networks play a large role in digital transformation. Common examples include businesses using Twitter, Facebook and the like as a means of customer service and engagement. Businesses have much to gain from using networks to connect with each other. Networks can also be the platform for customers to share their experiences with businesses or to access content and other services.

Networks should not be restricted to outside the enterprise—it is important that they also find a place within the enterprise. As Richard Branson of Virgin once said, “If you look after your staff, they’ll look after your customers. It’s that simple.” Within a business, sharing information unites the enterprise and can spark new ideas. Information gaps across the business or the lack of an employee network are inexcusable in our digital world. Lee Bryant from Postshift also stresses that the integration of internal and external networks is necessary. Information obtained from social media interactions with customers’ needs to be conveyed to other lines of business: operations, customer service, R&D, etc.

2.2.2 Businesses

Hyper connectivity has significant implications for businesses, which are a prominent part of society. The nature of hyper connectivity is forcing businesses to rethink their business models to cater to the demands and needs of the digital economy. This is due to the shift from connecting B2B commerce at an industry segment level, to an emergence of network of networks. Such Business Network Transformation is enabling digitization by connecting businesses with suppliers across all service categories in real-time, and at new levels of efficiency.

Businesses as a whole can be improved from internal-external collaboration. Better co-innovation with customers may require some restructuring of the business. Brian Solis, anthropologist, author and futurist, sums this up: “Businesses are no longer the sole creator of a brand; it is co-created by consumers through shared experiences and defined by the results of online searches and conversations.” After all, who knows better what consumers want than consumers themselves? It’s only natural for businesses to collaborate with their consumers, especially with networks available to help them to do so.

2.2.3 Communities

Hyper connectivity gives people the ability to form and engage with like-minded individuals, which allows for an exponential formation of specialized communities. One example of this phenomenon is Meetup, which is a web-based and mobile

[1]Derived from SAP Center for Business Insight 2015 calculation based on PwC, The sharing economy—sizing the revenue opportunity.

application, and the world's largest network of local groups. Through this application, anyone in a city or country is able to organize or join a local group and register their attendance at any local outlet, typically at cafes, restaurants or bars, in parks and even (idle) office spaces after work hours. There, the local community could physically meet and have a dialog on their topic of interest, ranging from entrepreneurship to yoga, local restaurants and food, gaming, book clubs, fashion, data science, to machine learning, and so forth. This in turn contributes to the sharing of knowledge, engaging in local commerce, and it also provides services—existing and potential—to name just a few. This is one such example of the impact of hyper connectivity on communities, which bridges the divide between the digital world and the physical world.

Businesses can also leverage communities to enhance customer engagement, drive personalized experiences and align efforts across the value chain to maximize value potential. A prominent example is Amazon, where people rely on the recommendation of peers. Such communities of interest are also behind other forms of commerce such TripAdvisor, Yelp, etc. that are building social capital for businesses.

There are many more such communities waiting to be 'uncovered'. Banks will fight for 'ownership' of communities of home owners, insurers will explore and nurture communities of car drivers, universities will capitalize on communities of students.

A clear recommendation: identify digital communities you may have access to as a business and explore ways of nurturing them for their and your advantage.

2.2.4 Sensors

Once a novel piece of technology, sensors are gradually becoming a commodity, costing increasingly less while becoming more reliable, and having a longer lifespan. Many types exist, ranging from motion or speed sensors, to light, optical or imaging sensors, force measurements, temperature or thermal, audio or acoustic sensors, humidity, proximity or presence, and so forth. The use of sensors will grow by a factor of 700 by 2030. As such, sensors can be utilized to help solve nearly every human need and want, ranging from smart shoes to cancer killing chips[2]. The ubiquity of sensors is a key driver for the IoT and big data—it is predicted that by 2018, the data created by IoT devices will reach 403 trillion gigabytes a year (Cisco 2015). When carefully harnessed, IoT can drive value creation via a real-time and predictive world.

The advent of new technologies like real-time data and connectedness allows for new innovations to occur. SK Solutions[3] in Dubai, for example, depended on new

[2]Derived from SAP Center for Business Insight 2015 calculation based on SPB Global, A trillion sensors is the equivalent of 150 sensors per human on earth.

[3]A global corporation specializing in anti-collision software solutions.

technologies to devise their anti-collision system: they harness the Internet of Things and real-time data to track cranes and other machinery to prevent potential collisions. Using the SK Asteroid platform solution, sensors on machinery capture and analyze Big Data to automatically make corrective adjustments to prevent all collisions, even those lying a week in the future. As a result, the safety and efficiency across some of the most complex industry landscapes is dramatically enhanced.

3 Supercomputing as Foundation for a 'Digitized Core'

Supercomputing refers to the ability of a high-performance computing (HPC) system that is able to perform at—or near—the currently highest operational rate for computers (Kindratenko and Trancoso 2011). A supercomputer is typically used for applications that require extremely fast processing speeds, such as for scientific and engineering applications that require very large databases or perform an enormous amount of computation (or both). Examples of such applications include performing complex calculations, simulation modelling or scientific research, and rendering high definition 3D graphics, to name just a few. Still, digital enterprises can leverage supercomputing to operate in real-time, achieve business agility and step changes in productivity, all while reducing the total cost of ownership.

Now, supercomputing gives us the opportunity to leverage massive parallel processing for the benefit of a faster processing of business transactions and analytical capabilities. An example for a technology that is leveraging supercomputing is the SAP HANA® technology. SAP HANA is an in-memory technology to use the computer's main memory instead of the hard drive for data storage and management. This builds the basic foundation to leverage multi processors in parallel. On top of this technology foundation, applications are built to fully leveraging the in-memory technology, e.g., with a new data model.

A model that does not have aggregates, no indexes and no redundancies anymore. This separates applications on this technology from classic application architectures build on relational database management systems (RDMS).

The aggregates and programmed indexes of RDMS, needed before the supercomputing and in-memory technology era, have no actual value and more. Systems can move from a read–write processing to an insert only processing. The past technology created complexity by creating interconnection in the application and locking down the system in order to avoid conflicts in updates of the aggregate. Complex and lengthy code had also to be developed for extract-transform-load (ETL) scenarios causing data preparation and latency, which in turn causes exception management. These parts of the code did not carry any business value for the business in itself but were necessary due to technical limitations.

With the in-memory technology these limitations become obsolete and thus aggregates.

3.1 Leveraging Capabilities of a Digitized Core: The Business Impact

One recent breakthrough in the tradition of supercomputing is the ability to eliminate the separation of transactional and analytical processing into one single platform, which significantly reduces cost, time, and enables business simplification and value creation.

We emphasize the importance of value creation with the supercomputing trend by introducing the notion of 'optimization levers'. As the digitized core as well as the digital economy is a new area, optimization levers of a digitized core have not been researched yet. Therefore existing concepts will be used to reference for the optimization levers. The term lever is used for tools or resources within an organization which can be used to improve business value (Rowsell-Jones 2007). In connection to IT, the term value or optimization is commonly used to describe the positive impact of IT on the business outcome and called IT business value (Devaraj et al. 2013). The digitized core optimization lever therefore refers to the *performance impact of a digitized core*.

Performance can be described in two ways. One of them is *efficiency* and is also referred as 'doing things right' (Drucker 1995)—in other words reduced costs or improved productivity to a given business process. *Effectiveness*, the second formulation, is defined as achieving objectives, which results in an advantage compared to peers (Barney 1991). In contrast to efficiency, effectiveness can also be summarized as 'doing the right thing'.

Here is the challenge: *Running a company versus Innovating a company*.

Analyzing the blueprint (business model) of organizations you identify significant differences in the setup. Line of Business (LoB) executives' responsibility has typically been to *innovate* the company and grow the business while IT Executives were *running* the company (at best efficiency).

Simply put this makes the definition of the optimization levers a first challenge for many companies. Is a digital core an IT or LoB spending? Is it costs or investments in the companies' future, focus on creating opportunities and growing business: prepare the enterprise for the next challenges to follow a different pattern.

Literature has been further divided by whether implementing an organization wide enterprise system is improving or worsening the organizations *agility*. One body of the literature argues that enterprise systems generate new complexity by connecting different processes and parts of business (Rettig 2007). The other side advocates that enterprise wide IT systems enable organizations to quickly react and adapt to changes (Anderson et al. 2003), thus proving positive impact on agility. More recent empirical research (Kharabe and Lyytinen 2012) showed that the organizational agility is positively influenced by the assimilation of the system. Therefore it is important for the digitized core to show a positive effect on agility or at least not lower it. Thus agility has been elaborated as the third and last dimension. Figure 2 summarizes the three dimensions of optimization levers of a digitized core.

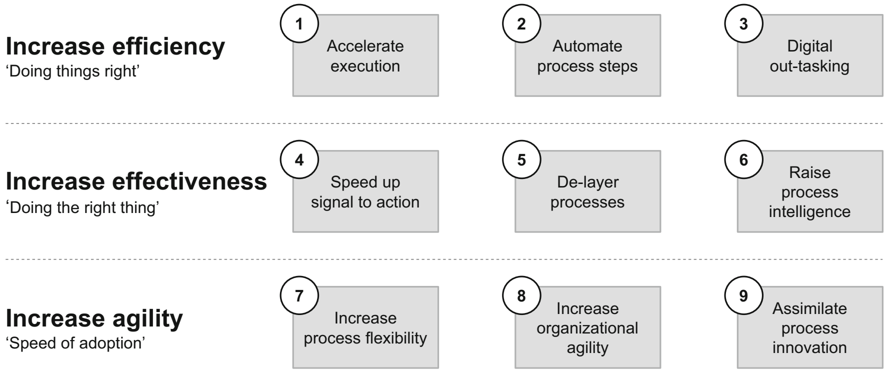

Fig. 2 Three dimensions of optimization levers of a digitized core

3.1.1 Efficiency Dimension

For the efficiency dimension three types of optimization levers are key: accelerating execution, automating process steps, and digital out-tasking.

Accelerate Execution

Given the amount of data in these ever increasing big data environment, analysis, long time-consuming batch processes or transactions are required to preselect information. This sometimes can take few seconds[4] but complex reports may take hours. With the digitized core-typical in-memory technology this is reduced to either a few seconds or just minutes respectively (see Fig. 3).

At that point we are talking about real time. This is where a digitized core shows its impact and value to the business: users (a.o.) can now rely on a single source of 'truth' and work with real time data. High volume data is not a show stopper for the system anymore and can be evaluated in real time, instead of overnight or over the weekend.

Automate Process Steps

But what if you do not have to wait at all because the task has already been done automatically? This is what the optimization lever 'automate process steps' allows

[4]Note that this time measurement is relative to the context of a business; for instance, in high transaction industries such as financial and insurance, if something needs more than a few seconds to load or transact, users move on to different tasks. This ultimately means that people have several unfinished workflows opened and can't focus on one and move on. Even if something takes longer than 10, one loses context and are prone to get distracted—meaning, the task is not finished as accurate and efficient as it could be.

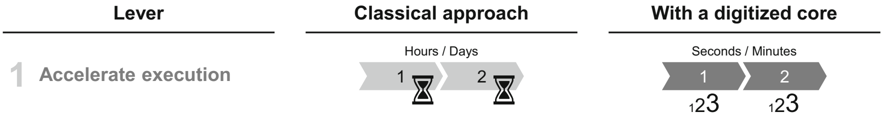

Fig. 3 The optimization lever 'accelerate execution' speeds up transaction processing time with a digitized core

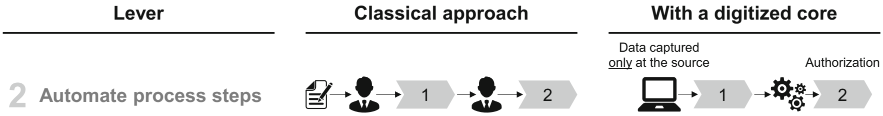

Fig. 4 The optimization lever 'automate process steps' increases zero touch point processes when enabled by a digitized core

(see Fig. 4). A routine task, which does not require careful manual input, can be automated with the help of the digitized core. Based on set criteria and algorithms, the system can decide whether a request needs a manual interaction or not. This highly increases zero touch processes.

One prime benefit of the 'automate process steps' value lever is that automated decisions free up the schedule and give employees additional time for important tasks. Here again, the data is captured only at the source which then allows dealing with a single set of data. It has proven to be highly beneficial in several use cases; every user, no matter how they are involved in the project, works with the same data and the interaction between people is improved by automated process steps.

Digital Out-Tasking

With a digitized core, digital out-tasking becomes much easier. Compared to out-sourcing, out-tasking means that you still manage the basic part of the whole process, but steps in between can be outsourced to external services. This allows one to focus on what really matters, and leave the rest to experts in that field. This will increase the efficiency of your processes and reduce costs in several ways. By leaving processes like deep market analysis or mining of external customer data to experts, you can use the saved cost to invest into your core capabilities and exploit them towards a competitive advantage. Figure 5 illustrates the described value lever coined 'digital out-tasking'.

With this we conclude the efficiency dimension. We next outline the effectiveness dimension and its value levers.

3.1.2 Effectiveness Dimension

For the effectiveness dimension we describe three kinds of optimization levers: speeding up signal to action, de-layering processes, and raising process intelligence.

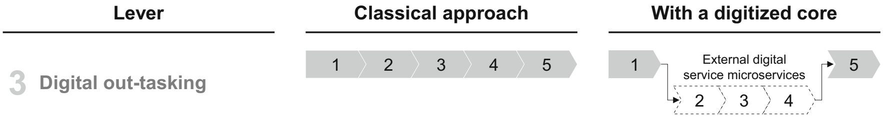

Fig. 5 The optimization lever 'digital out-tasking' allows businesses to focus on their core activities via out-tasking particular activities

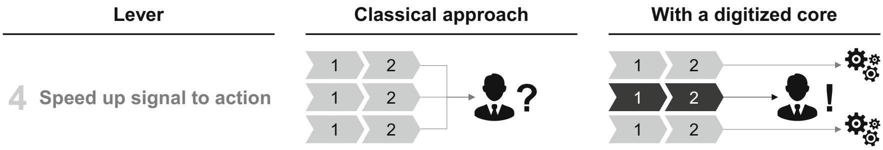

Fig. 6 The optimization lever 'speed up signal to action' allows personnel to make quicker decisions and corresponding actions

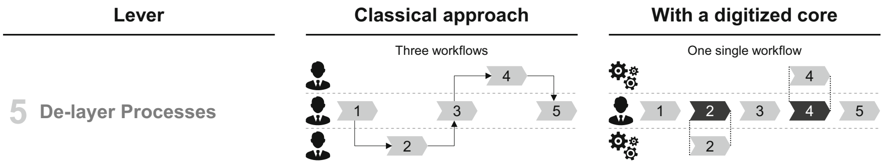

Fig. 7 The optimization lever 'de-layer processes' speeds up business data related decisions by merging workflows into one

Speed up Signal to Action

Speed up signal to action is a result of the previous lever 'automate process steps'. If you automate a large portion of processes, there might still be some important ones among them needing careful human evaluation. This is where the affected person gets notified by what is known as the signal. Before, the user would have gotten tons of these signals every day, and had to consider and evaluate each and single one of them manually. If the user now, with the digitized core, gets only a few signals, he knows that these are important and can attend to them 100 % (see Fig. 6). The decision, the action, follows much faster now, enabling one to do the right thing, i.e., to be more effective. We also regard this act as exception handling.

De-Layer Processes

Our fifth optimization lever is the de-layering of processes. It is an advancement of automate processes and emphasizes that multiple workflows cannot be merged into a single one (see Fig. 7). Before this, an agent needed to, for instance, retrieve information from an analyst. He had to request it and wait for the analyst to manually forward an answer. The agent also needs approval from his manager, which again involves manual interaction from that side resulting in lost time for everyone. By automating the two interactions from the analyst and the manager and seamlessly integrating it into the workflow from our agent, he can now finish the task in one go and not lose focus. This, for instance, can support the detection of fraud, by taking complexity from workflows and making them more transparent. It is now possible to bring multiple de-layered processes and involved stakeholders onto one single platform; and make business data related decisions much quicker.

Raise Process Intelligence

Optimization lever number six lies in making our processes even smarter. With the classical approach one would typically tend to rely on intuition as well as on delayed information, often outdated and likely to be flawed. This information would often be collected manually. However by capturing data, like click patterns, sensor data or geographical data, digital enterprises can now make decisions, based on real-time information, that are highly accurate. Making big data 'smart' and using predictive algorithms, analytics are enriched and then embedded into the process in order to help businesses do the right things. Process intelligence improves dramatically due to the build system simulations and business recommendations. Figure 8 illustrates the 'raise process intelligence' value lever.

Here we conclude the effectiveness dimension. The next section involves the much desired capability of a digitized core—leveraging the optimization levers of the agility dimension.

3.1.3 Agility Dimension

For the agility dimension we illustrate three types of value levers: an increase in process flexibility and in organizational agility, and also assimilating process innovation.

Increase Process Flexibility

Increasing process flexibility is the first optimization lever in the agility dimension. Flexibility can be defined as the ability to respond to a change in the environment,

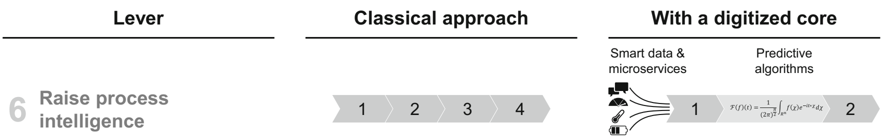

Fig. 8 The optimization lever 'raise process intelligence' raises the 'smartness' of enterprises with a digitized core

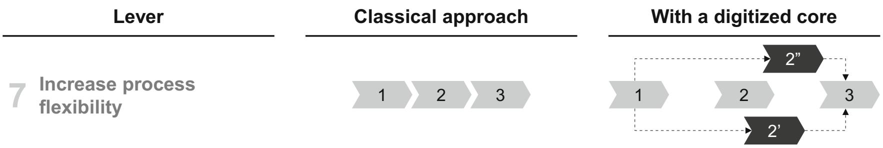

Fig. 9 The optimization lever 'increase process flexibility' speeds business operations with the freedom to personalize processes

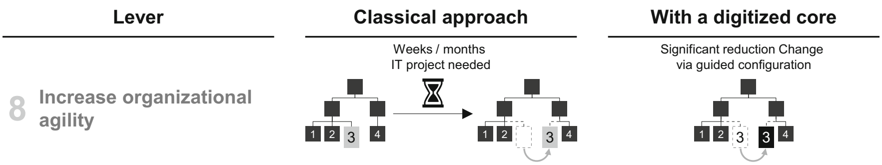

Fig. 10 The optimization lever 'increase organizational agility' realizes seamless organizational integration with a digitized core

without disappearing or being replaced. In the context of business processes this becomes the ability of that process to adapt to changes. An example might be where a LoB sees the need to change a fixed process for the department so the process gets easier to use. Changes like this were only possible through high effort IT investments and adoptions in the past.

Now digital enterprises can increase their process flexibility, as illustrated in Fig. 9. Our observations indicate that digitized cores don't just embed in-memory (super) computing; equally important are usability and intuitiveness. Having a personalized Graphical User Inferface (GUI) allows users to define their own processes or alerts without any deep IT knowledge—on the fly and on any device.

Increase Organizational Agility

'Increase organizational agility' describes the new ability to easily change the organizational structure without having to deploy an IT project, which translates to significant time savings. Usually the representation of the structure of an organization within an IT system lags behind actual structure, since organizational changes actually have an immediate effect. Especially when dealing with company mergers, affected processes and structures will be adjusted within shorter periods of time.

With today's capabilities and innovation available in a digitized core, a flexible collaboration both on business and IT levels between different LoB and is available. With new business insights and with blurring borders between LoB applications, it is now easy to introduce new organizations and employees to the new processes and adopt quickly (see Fig. 10).

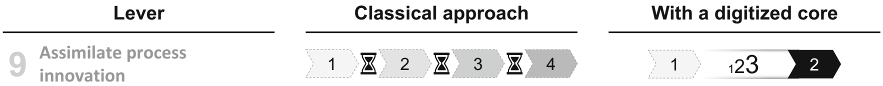

Fig. 11 The optimization lever 'assimilate process innovation' allows digital enterprises to speed up adoption of ideas to actual use

Assimilate Process Innovation

The digital economy constantly pushes and forces organizations to change and reconsider their processes; inflexible and stiff organizational constellations make this a complicated matter. This challenge however, could be partly met with a digitized core. This is because changes to business processes needing to be made and tested by IT are typically resource-intensive. This makes the process from the idea to the actual adoption and use of the solution a long road. However now, with a digitized core, changes can either be made directly by the users themselves, or deployed as a whole seamlessly (see Fig. 11).

Now that we have discussed all dimensions, we next discuss the impact on value creation.

3.2 Impact on Value Creation

3.2.1 From Changing Processes to Changing Business Models

Today's complexity unfortunately prevents a successful transformation. To solve this we need to tackle that complexity, unburden employees and processes and implement the digital transformation for your enterprise. The core therefore needs to be redesigned and updated to deliver on the new promise to the market.

First of all we want to explain the very basic value drivers of a digitized core, which all lead to the use cases. By implementing a digitized core and leveraging the new environment, companies of course have to decide how much impact they want to create. There are many opportunities for change, ranging from influencing single processes to transforming entire organizations and inventing new business models.

However, there is homework to do. Redesigning processes comes at a price. But the greater the effort the greater the ability to capitalize on it.

As shown on Fig. 12, on the very left, we are operating on a tactical level, punctual adaption of new technologies, for instance, only eases some processes—often only for IT. As we move further to the right, whole process chains get replaced with their digital equivalent, influencing all levels of an organization. Moving even more to the far right, we start having actual strategic impact; we start influencing our business value with the transformation and maybe innovate new business models which will finally disrupt the market in our favor and leave competition behind by acquiring new market shares and segments for us.

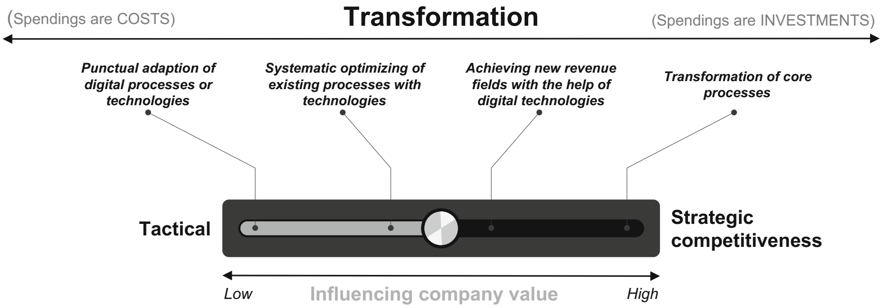

Fig. 12 Shifting tactical spending from costs to investments for strategic competitiveness

Spending thus become investments and success gets measured differently. New revenue streams are enabled as the way we run existing revenue streams are optimized. We improve the competitiveness of our company. In the end, however, it depends on leveraging the opportunities with a digitized core, during the transformation of your enterprise.

Having described the supercomputing trend, and importantly, how to benefit from the optimization levers, we next describe a fundamental enabler for digital transformations, cloud computing.

4 Cloud Computing

Cloud computing refers to a type of computing that delivers IT-enabled capabilities (such as software, hardware, platform and infrastructure) as a service using internet technologies. It uses a network of remote servers hosted on the internet—aka 'in the cloud'—to store, manage, and process data, rather than using a local server or a personal computer. This in turn allows for scalable and elastic use of computing capabilities, examples being: a controlled interface, ubiquitous access, virtual business environments, addressability and traceability, and rapid elasticity (Iyer and Henderson 2010).

4.1 Cloud Delivery Models

Cloud computing is big business, with a projected revenue generation of $270 billion by the year 2020[5]. Furthermore, more than 90 % of all data from IoT to be hosted in the cloud[6] to reduce complexity of supporting IoT 'data blending'.

[5]http://247wallst.com/technology-3/2015/03/07/the-270-billon-cloud-computing-market

[6]IDC, Connecting to IoT: The Road to Success.

Organizations can subscribe to four types of delivery models: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS), and Business Networks as a Service (BNaaS). Each of these cloud delivery models are described in the Table 1 below:

In summary, regardless of the type of delivery model, cloud computing offers businesses not only the flexibility to conduct their day-to-day business operations,

Table 1 Cloud delivery models

Delivery model	Description	Examples
SaaS (Software as a Service)	• Provides the ability to transfer programs to millions of users through a browser • For the user, this can save cost on servers and software, whereas for the provider, they only need to maintain one program, which can also save cost (Zhang et al. 2010) • Eliminates the need to install and run special software on one's PC, with a pay-per-use pattern that can reduce the total cost (Gong et al. 2010)	• SAP Lumira® Cloud • SAP Business ByDesign® • Google Apps • Microsoft Office Online
Paas (Platform as a Service)	• Provides development environment as a service, where the middleman's equipment can be used to develop one's own program and transfer it to users via the internet (Zhang et al. 2010) • Functions as the middle bridge between hardware and application (Gong et al. 2010) • Provides an entire computing platform in the cloud including hardware, software and open APIs to create new solutions and businesses	• SAP HANA Cloud Platform • Microsoft Azure • Force.com • Cloud Foundry
IaaS (Infrastructure as a Service)	• Delivers huge computing resources such as processing capacity, storage and network, where a user pays for just the consumption without having to purchase any hardware, or know the whereabouts of the data being dealt with (Gong et al. 2010) • Businesses are leveraging IaaS to get up and running in a matter of hours without spending significant capital expense	• SAP HANA Enterprise Cloud • Amazon Cloud • Rackspace
BNaaS (Business Networks as a Service)	• Companies in the value chain act as one entity to serve the end consumer, which entails an orchestrated business network of design and channel partners, suppliers, outsourced, co-innovators, customers, and even competitors • Companies build new competencies in managing collaborative relationships, with clear process handoffs, access to information, service level agreements, plus checks and balances on product quality and brand promises, and visibility into risk and performance across the business network • Each entity focuses on its key differentiation while collaborating with others in its network to deliver higher shared customer value, agility in innovation, plus cost benefits	• SAP Ariba® • Tradeshift OB10 • Procurify

but also the agility to deploy off-the-shelf or custom built solutions that can enable them to innovate their (digital) business models. We describe in the next section the consequences of cloud computing, particularly in the way the economy is measured as a result of digitalization.

4.2 Cloud Computing and the Subscription Economy

Driven by several macroeconomic trends we observe a significant shift towards a subscription economy. This drives new expectations and, at the same time, enables a new quality in measuring consumption.

The cloud deployment model is ideal for today's challenges. The advantages of cloud solutions lie in fast on-boarding, scalability to business, and easy access from everywhere and from any device. Not only that, but cloud source code never gets old as it is instantly updated upon release. Customers do not have to worry about upgrades; after all, it's a software as a service. Instant access leads to maximum business agility.

The subscription economy entails two main aspects: usage and consumption. There is no shelf-ware in the cloud. The expected agility and innovation cycles are at an unprecedented pace of change. Customers today are looking for ways of transforming their businesses to cater to our digitized, networked, and complex world. The prerequisite is to consume services rather than products, and if you want to digitally transform then everything needs to happen fast. Thus, consumption and respective benefits need to be measurable. Only with measurement is it possible to prove and derive value for customers and secure new business. The relatively low switching costs of services make it easy for customers to not renew or reduce their footprint. The most important advantage for enterprises in this no longer lies in bottom line reduction rather in business nimbleness time to value.

Consumption and behavior analysis will provide the capacity to improve continuously. Running the best businesses requires measuring achievements continuously, including benchmarking and going beyond expected business outcomes.

Usage measurement in the subscription economy is a key success factor for both, the customer and the service provider. Monitoring and measuring service usage is critical as it contributes to the identification of process improvement initiatives within an enterprise. Analyze consumption and adoption, uncover usage patterns, and benchmark organizations, this helps customers improve processes, increase efficiency and drive fact-based best practices across organizations. With the architectural framework of modern technology like Big Data Analytics, companies must apply measurement consistently across the solution portfolio to gain the right insights. Companies have to be mindful about what they measure. Becoming a data fanatic is not the purpose—becoming data driven, on the other hand, is.

Consumption insight goes beyond pure usage measurement. The question is not only whether the solution or only parts of it are used, but also *how* effectively it is used to optimize business outcomes.

Next, we present the fourth technology trend, smarter world.

5 Smarter World

Smarter world refers to the act of transferring data, knowledge and information seamlessly and meaningfully among networks of objects and/or users. The implications of operating in a smarter world has significant potential for businesses in offering novel, ubiquitous services, in the right place, at the right time, by the right means and with some level of smart or intelligent behavior, enabled by a ubiquitous, computational intelligence pervasion of the physical world.

5.1 Key Innovations for Smarter World

In the near future, the increasing miniaturization of computing technologies will result in processors and tiny sensors being integrated increasingly into everyday objects (Bohn et al. 2004). This will in turn lead to the disappearance of traditional PC input and output media such as screens, mice and keyboards. We will communicate directly with our clothes, watches, furniture and the like; these objects will, in turn, communicate with one another, and with other people's objects, too (Mattern 2004).

A high increase in cost-efficiency can be observed for other technological parameters like communication bandwidth and storage capacity. Prices for microelectronic functionality with a corresponding amount of computing power are falling drastically over time. This trend implies that computer processors and storage components will become far more powerful, smaller, and cheaper in the future, leading to an almost unlimited supply of ubiquitous technology.

We describe next at least four key innovations that contribute to a smarter world: smart products, smarter robots, smarter printing, and artificial intelligence.

5.1.1 Smart Products

Smart products are physical artefacts that are able to connect to users, systems and also other products, in order to provide a meaningful service autonomously. 74 % of US and European retail, healthcare and manufacturing companies have already developed smart products (The Economist Intelligence Unit 2015). Once composed mainly of mechanical and electrical parts, these products have become complex systems that combine hardware, data storage, microprocessors, sensors, software, and connectivity in a plethora of ways. Smart products are made possible largely due to the significant improvements in processing power and device miniaturization, and also by the network benefits of ubiquitous wireless connectivity. In turn, smart products offer exponentially vast opportunities for new functionalities, much greater reliability and higher product utilization, as well as capabilities that transcend conventional product boundaries. Smart products offer at least four kinds of capabilities and benefits (Porter and Heppelmann 2014):

1. *Monitoring*—Sensors and external data sources enable the comprehensive monitoring of the product's condition, the external environment, and the product's operation and usage. Monitoring also enables alerts and notifications of changes. This data has important implications for design (by reducing over engineering, for example), market segmentation (through the analysis of usage patterns by customer type), and after-sale service (by allowing the dispatch of the right technician with the right part, thus improving first-time fix rate).
2. *Control*—Software embedded in the product or in the product cloud enables: control of product functions, and personalization of the user experience by means of customization of product performance to a degree that previously was neither cost effective nor often even possible.
3. *Optimization*—Monitoring and control capabilities enable algorithms that optimize product operation and use in order to: enhance product performance, and allow predictive diagnostics, service, and repair. This enables firms to optimize service by performing preventative maintenance when failure is imminent and accomplishing repairs remotely, thereby reducing product downtime and the need to dispatch repair personnel. Even when on-site repair is required, advance information about what is broken, what parts are needed, and how to accomplish the fix reduces service costs and improves first-time fix rates.
4. *Autonomy*— Combining monitoring, control, and optimization allows for autonomous product operation, self-coordination of operation with other products and systems, autonomous product enhancement and personalization, self-diagnosis and service. The value of these capabilities can grow exponentially as more and more products become connected.

The shifting nature of smart products is disrupting value chains and evoking a new wave of competition and opportunities, pressing companies to repurpose and reimagine almost everything they do internally. As a consequence, strategic management are to consider: how value is created and captured, how the immense amount of new and sensitive data generated are utilized and managed, how relationships with business partners are redefined, and, what role companies ought to play with the shifting industry boundaries. An example is the intersection between technology and fashion with wearables like fitbit, smart watches, mixed reality glasses, and the like—in this instance the roles of each industry player shifts as there is increasing demand by consumers to not only satisfy function (via digital technology, smart components), but also form (via fashion, design, aesthetics) for usability.

In short, smart components amplify the capabilities and value of physical components, while connectivity amplifies the capabilities and value of the smart components, enabling some of them to exist outside the physical product itself. The result is a virtuous cycle of value improvement.

5.1.2 Smarter Robots

Robots can be seen as a type of smart object. However, some of them are aimed at human-like behaviors with relatively high intelligence and more complexity than when compared with everyday smart objects (Ma et al. 2005). Earlier studies have reported on how service robots (such as vacuum cleaners, lawn mowers, etc.) outnumbered industrial robots in 2005, with an expected quadruple effect by 2008 (Bartneck et al. 2007). This observation have since then increased significantly where the usage of robots for both private and commercial purposes is predicted to grow 2000 % from 2015 to 2030, and forecasted to be a $190 billion market[7].

To date, robots have mainly been replacing manual labor, performing routine and intensive tasks. However, smarter robots are putting more skilled professions at risk. Such concerns are triggered by emerging technologies that automate physical tasks via robotics, intellectual tasks via cognitive computing, and customer service tasks that range from self-help kiosks to grocery store scanners (Gownder 2015). A study by Bank of America indicates that 45 % of manufacturing tasks are likely to be performed by robots by 2025, which contrasts with today's 10 % (Kottasova 2016). By the same year, nearly half of all U.S. jobs will be at high risk of being lost to computers, with an additional 20 % facing medium risk, according to experts at Oxford University. This is due to, in part, advancements in usability of robots, with features like machine learning, and voice and facial recognition, which makes them a more viable alternative in jobs where people deal with customers. In addition, with the increasing cost of labor and decreasing prices of robots and computers, robots are even more attractive to employers. Costs have declined by 27 % over the past decade, and are further expected to drop by another 22 % in the next decade, as stated in the Bank of America report.

Countries that are early adopters of new technologies can expect a significant increase in productivity, also from lower labor costs. Japan for instance, is no stranger to adopting robots with already 1520 robots per 10,000 employees in their car plants, in contrast with only 66 per 10,000 worldwide. China, which overtook Japan, has been the biggest buyer of robots for the last 2 years, accounting for 25 % of global demand. In one manufacturing facility in China, a production line of 40 people 3 years ago would produce 800 units of computer mouse every hour. Now with robots, ten people can produce the same amount. Benefits of using robots, other than monetary value, is the ability to cut down on mistakes and eliminate problems caused by high turnover.

Robots have also been applied across many other industries, particularly with advancements in Artificial Intelligence. In one case, a team of smart robots (communicating via radio devices, bounded within a particular range) were deployed to explore trees, where the mobile robots can decide based on local, partial

[7] SAP Center for Business Insight 2015 calculation based on The Boston Consulting Group, The Rise of Robotics.

knowledge, and exchange information gathered during the exploration (Dynia et al. 2006). There is no central authority that knows the graph to control the movements of the robots—they have to organize themselves and jointly explore the trees. By using deterministic distributed algorithms, the experiment truly emphasizes the phenomena of self-organization, and that the more robots are deployed, the faster they could complete the exploration of the terrain. Another impactful use case where smart robots accelerate a business process is in research on cancer treatments by finding optimal treatment combinations (Dynia et al. 2006). Patients with the same cancer type who return multiple times would at times develop resistance against the pharmacotherapy used. The new robot systems therefore plays a critical role in the efforts to find new drug compounds that make these resistant cells sensitive again (Uppsala Universitet 2015).

In spite of the threat of replacing some jobs, the strategic use of robots and automation could actually lead to the growth of many new jobs, including ones under entirely new job categories. As such, the largest impact will be job transformation, where humans find themselves working side by side with robots (Gownder 2015). The challenge for decision makers would be to choose, pilot, implement, and evaluate these technologies, ensuring that these technologies do not just cut costs but actually drive customer value.

5.1.3 Smarter Printing

There are seven different types of printing technologies, as defined by the American Society for Testing and Materials (ASTM) International. One of them entails 3D printing as an additive manufacturing technique—as opposed to subtractive manufacturing—that utilizes a device to create physical objects from digital models (Gartner 2014). In a conventional stamping or assembly-line process, production is strictly analog, where sensors and automation are typically used to retrofit digital awareness and control onto the process. But when 3D printing is used to manufacture parts, that aspect of the process becomes inherently digital, where every element of each part is produced under the continuous control of software, creating greater visibility and control. Developments, such as embedded digital serial numbers in every part, provide instant access to full part history and traceability, as well as a recentralization of manufacturing supply chains as labor costs become less of a concern for factory location.

The usage of 3D printing will grow 2000 % from 2015 to 2030[8]. By 2018, 3D printing will result in the loss of at least $100 billion per year in intellectual property globally; yet in the same year, at least seven of the world's top 10 multichannel retailers will use 3D printing technologies to generate custom stock orders (Gartner 2014). 3D—in combination with smart technologies, contributes to the expansion

[8]Derived from SAP Center for Business Insight 2015 calculation based Forbes, Roundup of 3D Printing Market Forecasts and Estimates.

of personalized products and services (The Economist 2011). In the age of the customer, consumers want everything customized to their needs and wants, including the physical goods they purchase. 3D printing makes tailored products economically viable for a vast set of products and margin structures. An example is Startup Sols, which uses 3D printers to offer its customers affordable tailored insoles at scale.

3D printing has already transformed certain industries. More than 90 % of hearing aid shells (for microphones, electronics, in-ear aids, etc.) are produced with 3D printing today (The Economist 2011). Other use cases of 3D printing technologies include automotive and dental or healthcare industries. Organovo 'bioprinted' over 400 human livers in January 2014, with plans to commercialize the practice by the end of the year. The aviation industry, too, has scaled 3D printing as part of its production. Take for instance Airbus, a renowned, multinational commercial airplane manufacturer. The company saves millions of dollars in parts production and fuel costs by reducing the gross weight of an aircraft via 3D printing (Mearian 2014). Waste materials also dropped from 90 % to between 5 and 10 %. The company's vision extends beyond just printing parts. Curtis Carson, head of systems integration, at the Airbus Centre of Competence Manufacturing Engineering states that the corporation also plans to entirely print a 3D plane. This ambition is achieved in real-estate, where a company based in Shanghai built the world's tallest 3D printed building in January 2015 (Chan and Danby 2015). Simultaneously in June the same year, a Dutch design company revealed plans to use robots to 3D-print a bridge made out of printed steel over the Amsterdam Canal in 2017 (Thompson 2015).

In summary, the implications of 3D and Smarter Printing go beyond providing products faster to customers. One on hand consumers can customize their product design and print them at their own convenience. Companies, too, can respond to emerging requests much more rapidly, such as printing spare parts on-demand that bear a transformational effect on the retail industry, and hinting at new technology directives (Gartner 2014). Marketing and operations management can expect a transition from restrictive to ideal design manufacturing. IT professionals must therefore look into the feasibility of adopting the technology to their business and what implications the technology may have on existing supply chain operations as well as new offerings and new markets (Vargas et al. 2014). As a result, companies can gain value from smarter printing with faster time to market, reduced cycle times, and also reduce supply chain cost and new revenue sources (The Economist 2011).

5.1.4 Artificial Intelligence

Artificial Intelligence (AI) refers to the concept and capabilities that strive to mimic human intelligence through experience and learning (Lo Guidice et al. 2015). Google Brain, is one of the early cases of Google's initiative that is demonstrating the enterprise's ability to leverage the capabilities of AI, ultimately driven by deep-machine learning (McMillan 2014). In one experiment, the researchers asked, “If we think of our neural network as simulating a very small-scale ‘newborn brain’ and show it YouTube video for a week, what will it learn?” (Dean and Ng 2012). They hypothesized that it would learn to recognize common objects from still frames from unlabeled YouTube videos, which it did: one of the neurons in the artificial network learned to detect cats, without being told what a cat was, nor was it given even a single image labeled as showing a cat. Instead, the Brain ‘discovered’ by self-taught learning (Le et al. 2012), what a cat looked like only from unlabeled YouTube stills. Now with Brain, Google can scale its capabilities such as by transcribing all of the addresses that Google Street View has captured in France in under an hour (McMillan 2014). With its self-driving car project, the digital enterprise is aiming to commercialize autonomous cars by 2020 (Shepardson and Lienert 2016).

What makes AI a key contributor to a smarter world lies in the capabilities of AI of being able to elaborate reasoning models in answering intricate questions and solving complex problems; this forms the enterprise’s so-called cognitive computing systems. Such systems possess the fundamentals required to deal with the scale of computing power and storage, as well as big and diverse structured/labeled and unstructured/unlabeled data, and also ubiquitous, smart software: computing power, storage, algorithms, machine learning, natural language, accessibility, and infinite amounts of data. As energy consumption can be reduced by a factor of 10,000 in 5 years’ time, AI and its deep-learning functions are predicted to be accessible on mobile or wearable devices (Larson 2015). Hence, the rise of AI will only accelerate the uptake of robots, particularly when the number of devices connected to the Internet doubles to 50 billion by 2020 (Kottasova 2016).

AI is entering the enterprise world in multiple forms. Trading companies and wealth advisors are using highly trained neural networks to support human investors (Chen 2013), similarly, large consulting corporations are partnering with technology providers and applying AI methods (neural networks, expert systems, machine learning) to support individual employees in their decision making. This hybrid approach, where humans are supported by AI algorithms is becoming more and more common in knowledge intensive organizations. Other forms of AI use in digital enterprises include computer vision algorithms and image processing methods for production control, using AI algorithms to predict and prevent customer churn in telecommunications industry or, in more advanced scenarios, using AI in robotics solutions (self-driving trucks in mining or domestic helper robots). We will continue to see AI being used more and more often, and digital enterprises will increasingly use AI to augment human tasks. In most knowledge intensive tasks we are still at least a few years away from the moment when AI will fully take over human tasks, however—given the recent advances we have been witnessing—it is entirely possible that such a transition will start happening sooner rather than later.

5.2 *Implications of Smarter World*

Digital innovation and transformations take place not just through being enabled by one technology, but rather, as a result of a successful orchestration of digital technologies, all in a context-aware fashion. The configuration of capabilities from selected strategic partners within the digital and physical ecosystem is an important step in innovating towards digital business models, which can be achieved by leveraging the aforementioned innovations for a smarter world.

Last, we discuss a critical technology trend that is imperative for the digital economy, cyber security.

6 Cyber Security

Conventionally, one would most often associate cyber security with antivirus software on personal PC, or security applications on smart, mobile devices. But cyber security is more than that; cyber security refers to the body of technologies, processes and practices employed to protect the cyber world as well as organization and user's assets from attack, damage or unauthorized access. Organization and user's assets include connected computing devices, personnel, infrastructure, applications, services, telecommunication systems, and the totality of transmitted and/or stored information in the cyber environment.

Nowadays, cyber security is attaining larger concern due to the uncertainties embedded in unknown consequences on the use of advanced, digital technologies. Five out of six large companies were targeted by cybercriminals, which represents a 40 % rise from 2014 (Symantec 2015). Moreover, globally, cybercrime costs businesses US$375–$575 billion annually, and a net loss of up to 200,000 jobs in the U.S. alone (McAfee 2014). The consequences affect all aspects of society vulnerable to threats and damages, ranging from individuals to businesses to national and personal security or those who depend on and trust their information with—this shows the pressing need for organizations to increase their efforts and investments in cyber security, to ensure the safety of not just their commercial information, but that of its customers, too.

6.1 *Four Cyber Security Elements*

Essentially, the aim of cyber security is to ensure availability, confidentiality, and integrity (including authenticity and non-repudiation), as well as the attainment and maintenance of the security properties of the organization and user's assets against relevant security risks in the cyber world, particularly on data, interactions, identities, and partner with trusted suppliers.

6.1.1 Securing Data

One of the prominent attributes of the digital economy is the wealth of data generated by people and things. Companies that fail to perform their duty of care on protecting data can expect severe repercussions not only for its customers and the business itself, but all affected parties in the ecosystem. One example is the biggest retail hack in U.S. history, where Target Corp.'s security and payments systems across 1797 U.S. stores were severely compromised with a malware on Thanksgiving 2013 (Riley et al. 2014). Perhaps the biggest distress is when the corporation stood by as 40 million credit card numbers, 70 million addresses, phone numbers, and other pieces of personal information leaked from its mainframes, resulting in more than 90 lawsuits filed against Target by customers and banks for negligence and compensatory damages. The company paid US$39 million to banks and credit unions to resolve the losses, which is but one indicator of the significant damage that could be brought onto organizations that are negligent of their customers (Rosenblatt 2016).

As such, securing data is critical in the digital economy, which requires at least the following:

- Companies and their partners to stay compliant with data privacy and compliance regulations,
- Understand local data controls.
- Establish encryption classification criteria.

6.1.2 Securing Interactions

As hyper connectivity allows for constant and instantaneous communication among people, businesses, communities and things, it becomes even more imperative to secure the interactions and communications among these entities. Take the IoT, for instance, where digital enterprises are faced with not just the IoT devices themselves, but also the interactions or communications, platforms and operating systems, as well as the systems that they are connected to. Security protocols and technologies are necessary to protect IoT devices and platforms from information attacks, as well as to encrypt their communications, and to address new challenges like impersonating 'things' or denial-of-sleep attacks that drain batteries. However, cyber security solutions are currently fragmented and involve multiple vendors (Gartner 2016). Take another example where interactions are becoming increasingly digital, such as in connected communities involving the government and its citizens, where interactions concerning travel (passports and visas), health, taxes, and so forth, would require significant consideration on cooperating agencies. Therefore, management in digital personnel are to carefully consider the following in securing interactions:

- Joint Service Level Agreements should be in place with partners,
- Value chain interactions must be secured,
- Constant checks at the application level.
- Safeguarded connectivity to prevent wide-spread impact.

6.1.3 Securing Identities

Corporate spying and digital theft are on the rise. In 2014 alone there were four incidents of mega breaches, where each breach exposed more than 10 million identities (Symantec 2015). The total number of breaches increased by 23 % from 2013, which indicates that breach activities are continuously increasing. A survey conducted by Symantec (2015) shows that the retail sector was responsible for 59 % of all identities exposed in 2014, followed by financial sector with 23 %, computer software with 10 %, healthcare with 2 %, and government and public sector also with 2 %.

In spite of these numbers, it is also possible that organizations are withholding information on the number of identities exposed for a number of reason. First, organizations find it too challenging to determine the number of identities exposed. Secondly, unlike healthcare and some government organizations, most industry do not have laws that legally require organizations to report on breaches. As such, information concerning breaches remains undisclosed to help save face or minimize the negative impact on an organization's public reputation, and they do not have to pay penalties as a result. This however may change over the years as many governing agencies around the world are working on regulation surrounding proper disclosure of data breaches.

The risk in identity theft is intensified as digital technologies become increasingly pervasive and integrated in both work and personal domains. In addition to mobile and smartphones, wearable technologies are also playing a prominent role in receiving and transmitting data (e.g., location, transactions, personal health data, etc.), forming a rounded overall picture of an individual and their identity. This in itself presents a risk to the person, and its ecosystem including assets, partners, suppliers and so forth. The interesting thing with wearables is that, owners may feel that their devices are less likely to fall into the wrong hands, as those devices are close to their body. However, hackers do not need to physical possess a wearable device in order to forge a hole in security. A survey[9] conducted by Centrify, a leading business in securing enterprise identities against cyberthreats, shows that 69 % of wearable device owners claim to forego login credentials like PINs, passwords, fingerprint scanners and voice recognition, when accessing their devices (Business Wire 2016). In spite of the lack of login credentials and ready access to corporate data, the survey also indicates that 42 % of wearable owners actually cite

[9]For this survey, Centrify polled more than 100 randomly-chosen participants at RSA conference, the world's largest information security event with nearly 30,000 attendees.

identity theft as their top security concern. This if followed by lack of IT management and device control (34 %) and an overall increase in breaches of sensitive work data or information (22 %). As such, it is critical for IT departments to take serious measures to protect wearables—or any kind of emerging technology—as they would for laptops and smartphones.

Implications for management on securing identities include at least the following:

- Access to digital information should be restricted to authorized users.
- There should be central authentication regardless of device.
- Devices must be maintained to prevent hackers from gaining access to your digital IP.

6.1.4 Partner with Trusted Suppliers

The digital ecosystem involves multiple key players who contribute to the value chain of any given business. And with the increase in emerging technologies that are disrupting traditional business rules, companies who have a high stake in the market are to carefully consider the implications of their partnership with (trusted) suppliers within and beyond their network. The impact of neglecting this issue could prove to be disastrous, shutting down business operations and bringing negative consequences to their customers. One prominent example to illustrate such impact is the renowned case of Ukraine's power plant hack.

On 23 December 2015, at approximately 5:00 pm, two power distribution companies in Ukraine claimed that hackers had intruded their systems, disconnecting breakers for 30 of its substations, and subsequently killing electricity to 80,000 customers (Zetter 2016). While only two admitted to having their systems hijacked, authorities reported of six more companies being hacked in up to eight regions of Ukraine. The country has 24 regions with different power companies serving each region that has 11–27 provinces. At some point, electricity was restored to the city of Ivano-Frankivsk, but workers were still trying to bring back power to the rest of the region.

In January 2016, Ukrainian media reported that the hackers had not just killed electricity, they had also caused monitoring stations at Prykarpattyaoblenergo to go 'suddenly blind'. Attackers were likely to have frozen data on screens, preventing them from updating as conditions changed, leading operators to believe that electricity was flowing when it was not. In prolonging the outage, the attackers evidently deployed a telephone denial-of-service attack against the power utility's call center to prevent customers from reporting the outage. They also sabotaged operator workstations when making their way out the digital door, making it harder to restore power to customers. When the operators eventually realized the outage, the hackers paralyzed the company's operations as a whole with malware that affected servers and PCs. A program known as KillDisk was discovered on the company's systems, which overwrites data in essential system files, causing computers to crash and then being unable be reboot, as it also completely erases the master boot record. Because the hackers had sabotaged management systems, workers had to travel to substations and restore power by manually flipping their antiquated circuit breakers, which the hackers had remotely opened.

All in all, the incident was a well-orchestrated, multi-pronged attack. While the capabilities used were not that sophisticated, the logistics, planning and execution of the methods of attack etcetera were well thought through. What is also interesting about the case is investigators stating that in the end, the Ukrainians may well have been rescued by their country relying on old technology, and have yet to reach the same level of digital maturity as many Western nations.

The downside for the mature countries, like the United States for instance, is that they are unable to replicate the same procedure as contemporary technologies have moved away from such an analog approach. Accordingly, following the Ukrainian incident, the Obama Administration in the United States urged vulnerable organizations to be alert and proactive in managing cyber security (Sanger 2016), particularly when multiple players are involved in the value chain; with 3200 power companies, and the country's administration requiring a precise balance between the amount of electricity generated and the amount used; which is only to be achieved over a system run on the Internet.

Implications for management in relation to partnering with trusted suppliers are as follows:

- Supplier relationships are key in establishing trust as more non-core processes are outsourced.
- Companies should build relationships with selected partners who will meet the highest security standards.
- This will also result in a more simple and nimble architecture.

6.2 Impact of Cyber Security

As many security issues are the resulting outcome of poor design, management personnel are to invest their efforts heavily in the matter of cyber security. In addition, the implementation and lack of training requires market leaders to also devote their attention to the overall architecture of an organization's digital core. They could for instance, manage security across digital business(es) through proper governance. This would in turn reduce their TCO, strategic and operational business risks, and bring about awareness of compliance breaches, strengthening the trust of their customers and partners within the ecosystem.

Among the critical factors to consider are data, whereby security and trustworthiness of interaction, as well as privacy of relevant data such as location, personally identifiable characteristics of users, etc. as well as partnering with trusted suppliers, will be of critical importance for a business to successfully operate and integrate with society.

Now that we have described the five technology trends, we next highlight the implications for businesses necessary for competitiveness—if not survival—in the digital economy.

7 Implications

Regardless of any technology trend, digital innovation and subsequently, digital transformation, can only be realized successfully by being aware of and prepared to address the core business needs. In the following we present two pressing implications for decision-makers: (1) digitize the core, and (2) digitize the mindset.

7.1 Digitize the Core

As a consequence of the new drivers, the ultimate goal for most companies is the *Unit of One*. And this is not only appealing for B2C, but also B2B2C companies, and subsequently with IoT, B2T, due to the new expectations that are changing the entire market landscape. A seamless, end-customer focused, and fully-individualized service *custom made* becomes an important term for digital enterprises.

Unfortunately the path to it is not a direct one. A lot is already in place today and is induced by changed technologies, like sensors, mobility, bar codes and others. As the customer segments are not fixed entities, companies see direct customer engagement as the first logical step.

In a changing market, the mindset[10] of business decision-makers should (ideally) steer towards ‘I want to be where my customers are’. We are increasingly witnessing, with advancements in technology trends, various means to innovate in the digital economy. Many new apps have been build, new internet presence, online and virtual stores, new services and offerings, the use of gamification to win customers attention—we label this as enterprises having a *Digital Storefront*. Its aim is to make buying more intuitive and user-friendly (Fig. 13).

Too often however, the infrastructure of lagging enterprises cannot deliver on the new promise created at the Digital Storefront. The number of incoming orders rises beyond control, and the size of each lot becomes smaller, which is one of the direct consequences of the *Unit of One* (see Fig. 14). And the same applies to invoices. The average value per invoice is decreasing while the amount of invoices is increasing significantly. This dramatically raises the workload and puts the whole organizational infrastructure to the test. Yet, many fail because the company infrastructure is no longer prepared to infinitely scale. The boundary conditions

[10]The ‘digital mindset’ provides further elaboration in Sect. 7.2.

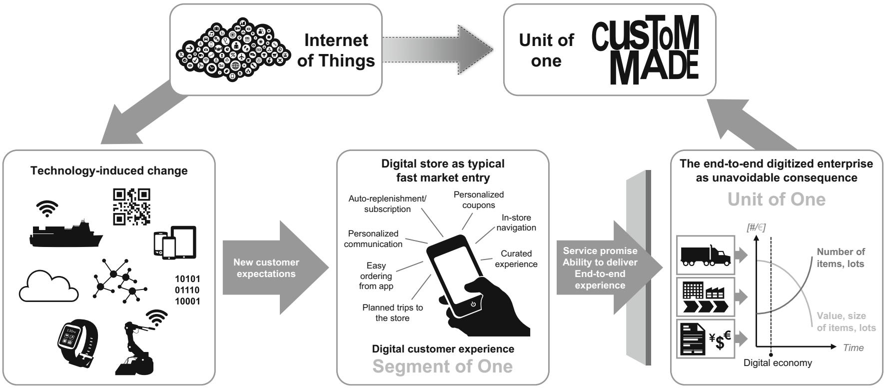

Fig. 13 Illustrating the drivers for businesses to function in a 'Unit of One' mode in the digital economy

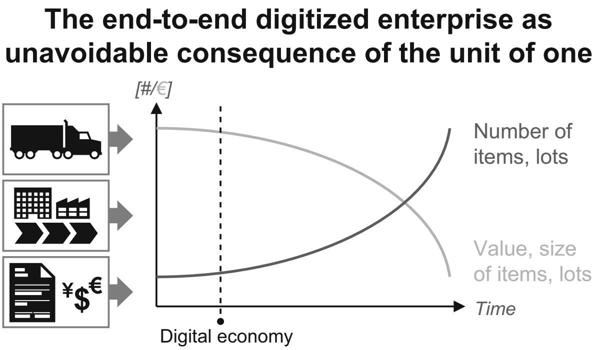

Fig. 14 The end-to-end digitized enterprise as unavoidable consequence of the unit of one

of the past are proving to be locking systems down. In other words, digital enterprises require the flexibility, agility and intelligence to operate as a collective whole, i.e., Unit of One, in its ecosystem.

According to McKinsey (McKinsey Global Institute 2011), some prominent issues experienced by digital enterprises include scattered information and data duplication creating different versions of reality. This subsequently complicates decisions, making it difficult for enterprises to bring good ideas to market quickly and profitably. It then moves on to business processes that have been built around long-running batch processes. According to a BCG report (Freese et al. 2014), organizations tend to spend between thirty and eighty percent of their time on non-value-added activities, wasting time and energy rather than solving genuine, business problems. This leads to our next section, where we also identify a critical implication for businesses in order to adapt to the digital economy.

7.2 Digitize the Mindset

The past 20 years, ever since Don Tapscott coined the term digital economy (Tapscott 1997), have forced a change in the way entrepreneurs and executives think about the business ecosystem. Digital economy has undoubtedly forced organizations to develop a new way of thinking: a digital mind.

The shift in the properties of, and the power distribution in the global economy can be captured by the evolution from 'economy of corporations' to 'economy of people' (see Fig. 15). In the economy of corporations, what matters is mass productions on a high scale. In the economy of people, the focus shifts to mass personalisation, with organization often focusing on 'the market segment of one'. In the economy of corporations, organizations have been focusing on cost optimisation, ensuring the most efficient use of resources available. An economy of people shifts toward revenue resilience—looking for new ways of satisfying consumer needs, exploring new markets, and new initiatives, ensuring that market exploration is at least as important as market exploitation (Voss and Voss 2012). The economy of corporations has developed tools and methods to analyse the past, while in the economy of people the focus is much more on designing the future.

The shift in the economies—from the age of automation to the age of digitization, requires entrepreneurs and executives to re-imagine and re-design the way they create revenue. We see a number of trends in the economy that are potentially threatening existing business models (while at the same time offering opportunities for those who spot them early on):

1. *Commoditisation of goods*. Digitization of products and services, coupled with changing customer expectations, dramatically changes the business landscape. Goods and services that in the past were sold at a premium are often available completely free of charge. Online education, navigation systems and applications or text messaging are just examples of the trend. While only a few years ago providers of such services were competing on prices, these days customers assume that many such services are completely free of charge, while expecting the same or often higher quality than in the past. This leaves businesses scrambling to find alternative sources of revenue.

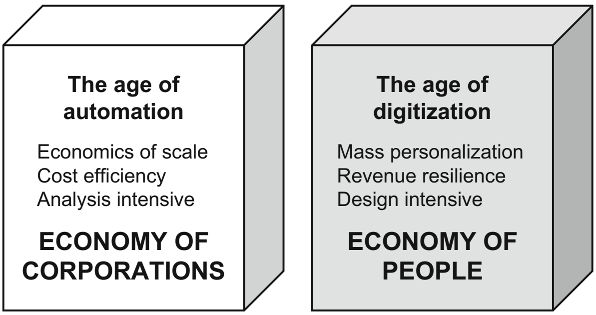

Fig. 15 Evolution from the 'Economy of Corporations' to 'Economy of People'

2. *Customers becoming competitors*. The sharing economy and platform applications made available by it, allows individuals to compete with large corporations. Transportation and hospitality industries are the ones impacted the most, but we are seeing signs of other industries being challenged by the model. These days a guest at a hotel can at the very same time be competing with the hotel chain by renting out their house in another city or country. Many incumbents, realising the disruptive power of platform applications, are entering the same space.
3. *New digital products and channels emerging*. Many industries have been disrupted not by competitors undercutting their prices, or providing better products and services, but by innovation coming from outside of the industry. Examples include high speed internet which disrupted media companies. Soon, we expect to see traditional fuel distribution channels to be disrupted by growing numbers of electric vehicles on the streets. To follow on, autonomous vehicles will likely disrupt many non-related industries, as an autonomous vehicle is effectively a platform for passengers to consume digital services, while not having to focus on the road anymore.

Successful entrepreneurs apply new thinking patterns to identify new opportunities. One such pattern is 'oppositional thinking'—observing the world and exploring possibilities of flipping existing business processes or business models. Australia's Carhood[11] is an example of a business that exactly applied such thinking patterns. The founders of the startup, not happy with the high prices that airport carparks charge, asked themselves: *What if airports paid drivers for leaving their cars?* Such an approach allowed them to come up with a breakthrough idea. Carhood allows drivers to park their cars at the airport and rents out the vehicles while the drivers are way. By copying the successful business model from other startups in hospitality space, ensuring proper insurance coverage, and competing on prices with established market players, Carhood has managed to grow, open offices at airports around Australia and is now expanding to other countries.

Applying the right digital mindset allows organizations to shorten the innovation latency. Appropriate thinking patterns allow organizations to spot the potential for innovation much earlier than before, analyse the potential of innovation, and finally adopt the innovation (cf. Recker and Rosemann 2015).

We believe there are seven core areas that a successful business should focus on in order to thrive in a digital economy, as illustrated in Fig. 16:

1. *Ability to capture digital attention of customers*. In the world of constant distraction, an organization needs to be able to creatively reach out to customers. Digital campaigns, applications, ability to understand customers, are key.
2. *Ability to process digital signals of customers*. More and more businesses and individuals are happy to share their 'digital signals' with others. Small and medium businesses, using cloud solutions to run their operations, are often a step away from sharing core data with others, and many of them do. A successful

[11]Got to http://carhood.com.au to explore and observe Carhood's well-designed offerings.

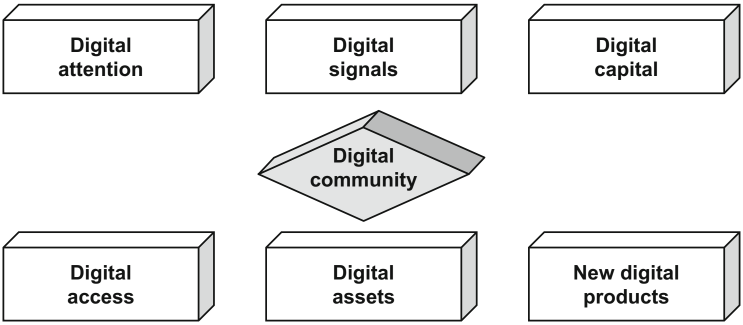

Fig. 16 Seven core areas for businesses to successfully thrive in the digital economy

enterprise will find a way of processing such signals to provide value back to those who share, while at the same time creating new, digital, services.

3. *Ability to integrate digital capital of customers*. Similar to digital signals, customers are often happy to share their digital capital, provided they see value in it. Individual customers may share their social network information, organizations may share their business network information. What if a business can deliver value based on such information? Forming syndicates of small businesses to negotiate with large vendors is one example of great potential that ability to integrate digital capital enables.
4. *Ability to foster digital communities*. Practically every business has a community of customers. Not many of them truly understand the power of the community in the networked sense. Only a handful of businesses around the world truly captures the power of customer communities. SAP's Community Network is an example of bringing together customers, solution providers and others. Successful digital communities are effectively locking customers in, not through legal tricks, but through genuine value that they generate.
5. *Ability to provide digital access to the organization*. While seemingly obvious, large numbers of organizations still do not have the right solutions to provide digital access to their services. In order to thrive in a digital economy, providing such access is critical.
6. *Ability to digitize assets*. What assets of an organization could be made fully digital? The more obvious examples include information digitization. The less obvious ones are automation of processes, using technologies such as digital assistants, or experimenting with artificial intelligence in order to perform some of the more basic (and occasionally more advanced) tasks.
7. *Finally, ability to create completely new digital products*. Revenue resilience requires organizations to explore the markets and, whenever possible, offer new, digital products.

As Jack Welch, a former CEO of General Electric (General Electric 2000, p. 4), said, "If the rate of change on the outside exceeds the pace rate of change on the inside, the end is near." The technology trends leave no doubt that the world is changing at an unprecedented pace. It is now up to entrepreneurs and executives to ensure that their organizations change just as quickly. And having the right digital mindset in addition to a digital core is key in this process.

8 Conclusion and Key Learnings

In this chapter we present the business consequences of five technology trends in the digital economy; these are: hyper connectivity, supercomputing, cloud computing, smarter world, and cyber security. We illustrate with ample examples and use cases how these technological advancements are impacting business models, business processes, and the way we work in the digital economy. We also show how these emerging technologies could enable a business to get ahead and stay ahead in the digital economy. However technology is not a business value in itself; decision makers are to avoid using technology for technology's sake, but ought to rather focus on the business outcome and benefit.

The fast changing market require a new setup and fundamentally improved capabilities. The typical 10–20 % improvement year-over-year are not sufficient in a digital transformed world. As such, companies are advised to not put themselves on the defense and rest on past success. Neither size nor past success will guarantee future success in a digitally transformed world. Furthermore, if a company is already losing market share, they will immediately suffer from a decreasing investment potential. Hence, enterprises are urged to not only change while they are in shape, but ultimately to re-invent—or transform—themselves.

Key Learnings

- The technology trends, viz. hyper connectivity, supercomputing, cloud computing, smarter world, and cyber security, promises to (digitally) enable innovation and transformation of businesses in the digital economy.
- The fast changing market or digital economy requires a new setup and fundamentally improved capabilities. This implies the necessity to digitize the core technology and, equally important, to digitize the mindset of decision-makers.
- Businesses are urged to change while they are still in shape. This is critical as organizations that are already losing market share will face a decreasing investment potential, while those who proactively disrupt themselves will reap the benefits of investments and stay ahead of its league.

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Marek Kowalkiewicz is an academic and industry leader with extensive experience in conducting academically sound research, co-innovating with industry and university partners, and delivering innovative products to the market. As Professor and PwC Chair in Digital Economy, he leads Queensland University of Technology's research agenda to inform and influence a robust digital economy.

Niz Safrudin is part of the Digital Innovation and Transformation team at SAP Business Transformation Services. She is based in Zürich since 2015, after completing her Ph.D. in IT-enabled business transformation at the Queensland University of Technology, Australia. Her background is in business process (re-)design, and in her present role, she explores with customers and partners how contemporary technologies such as wearables, augmented and virtual reality—when coupled with SAP solutions—can enable companies to re-imagine the way they run their business.

Bert Schulze drives Co-Innovation with Customer and Partner for SAP S/4HANA and globally leads the Regional Implementation Group for SAP S/4HANA. He also takes global responsibility for the SAP S/4HANA outbound product management. Before he was a senior member of the SAP Cloud Global Customer & Market Strategy Group. His key expertise areas are Co-Innovation, IT strategy of enterprise processes, SaaS, social and hybrid concepts. Bert Schulze holds a Master of Mechanical Engineering (Dipl.-Ing.) and a Master of Business (Dipl.-Wirt.-Ing.).

It's Not Just About Technology: The People Side of Digitization

Oliver Kohnke

Abstract Anything that can be digitized will be digitized! The process of digitization affects almost everything in today's organizations and puts huge pressure on these to change. Therefore, it is crucial for leaders to understand the implications of digitization on their organization and employees. Digitization not only changes the way of working, it also accelerates the speed of change that companies are facing. Both implications lead to three major requirements that have to be tackled to be successful: New skills and competencies, new forms of leadership, and new organizational capabilities. Depending on the degree to which organizations fulfill these requirements they will also evolve their culture towards a 'digital mindset'. But digital transformation initiatives are facing huge challenges to realize the expected business benefits. Current studies clearly show the importance of managing people and organizational issues in digital transformations. Organizational change management is considered to be a critical success factor for any digital transformation program and embraces four major areas: Aligning leadership (e.g., digital vision, role modeling), mobilizing the organization (e.g., communication), building capabilities (e.g., digital skills), and ensuring sustainability (e.g., adapting KPI and incentive systems). Furthermore, it will be discussed how change management has to be adapted to meet the requirements in a digital world.

1 Digitization as Technology Driven Organizational Change

Anything that can be digitalized will be digitalized, and the technologies and applications to support this process will become more and more sophisticated and powerful. Digitization will have huge consequences for current business models and practices. Most organizations have realized the importance and criticality of digital technologies for their industry or their own business. They want to become more 'digital', and the executive support for such initiatives is growing (Bughin

O. Kohnke (✉)
SAP Business Transformation Services (BTS), SAP Deutschland SE & Co. KG, Walldorf, Germany
e-mail: oliver.kohnke@sap.com

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et al. 2015). Digitization refers to "the increasing penetration of digital technologies in society with the associated changes in the connection of individuals and their behaviors" (Gimpel and Röglinger 2015, p. 5). Currently, four technologies are associated with digitization (Harvard Business Review Analytic Services 2014; Wade and Marchant 2014):

- *Analytic technologies* and applications including 'big data' that allow innovative forms of information processing for better insights and decision making.
- *Mobile technologies* like smartphones and tablets as well as applications that enable new business scenarios for customers, partners, suppliers, and employees.
- *Cloud technologies* and solutions that offer flexible and shareable digital capabilities (e.g., marketplaces, software as a service) to drive business agility.
- *Social media technologies* and applications that facilitate new forms of social interactions.

Together these fours technologies are having a tremendous effect on how organizations and industries are transforming themselves—and this process is occurring rapidly at a majority of organizations (Dörner and Meffert 2015). Furthermore, research found that the likelihood of being transformed towards a digital enterprise is significantly higher among those organizations that deem multiple technologies to be critical (Harvard Business Review Analytic Services 2014). It is not just about simply implementing these technologies to increase efficiency or to cut costs. Organizations are using digital tools and applications to drive innovation, e.g., developing new business models or customer journeys.

Digital experiments in the early stages of digital transformation such as innovation labs, incubators and new digital products have helped to cultivate digital capabilities and produced remarkable results (Dörner and Meffert 2015; Desmet et al. 2015). However, since digitization affects almost everything in today's organizations, any digital initiative requires an unprecedented coordination of people, processes, and technologies. Digitization is placing enormous pressure on organizations to evolve (Desmet et al. 2015). Therefore, becoming a digital organization requires fundamental changes regarding how organizations operate and do business (Dörner and Meffert 2015). One of the key questions is how to scale these capabilities in an upward direction while integrating them into the core business.

"None of the changes enabled by these technologies comes without accompanying organizational changes—management mind-sets, organizational behavior, operating culture" says Prof. Marchant of IMD. "Deep change over time coupled with these technologies is where transformation happens" (cited in Harvard Business Review Analytic Services 2014, p. 10). Digital technologies can only lead to improved performance through organizational change. At its core, digital transformation is change, and, as with every organizational change initiative, it must be managed with extreme care (Wade and Marchant 2014).

In addition, a digital transformation isn't a single effort but rather a portfolio of initiatives that work together to scale the change. Having a 'let a hundred flowers bloom' approach, where each initiative works independently in a spirit of experimentation, can lead to interesting and powerful results in all areas of ideation and innovation, but it is not a formula for scaling a digital transformation across an organization. Success ultimately depends on how management coordinates initiatives as they run at the same time (Dörner and Meffert 2015). New skills and organizational capabilities are needed to increase the organization-wide adoption of digitization. Managing the transition to a digitally driven business model isn't just critical in order to outperform competitors—it's crucial for survival (Desmet et al. 2015; Lucas and Goh 2009). Leaders of digital transformation programs have to come to understand the implications of digitization on their organizations and the people working in them.

2 Organizational Implications of Digitization

2.1 Current Challenges of Digital Transformation Programs

With the widespread availability of digital technologies and applications it has become more and more of a common practice to launch digital transformation programs implementing these digital solutions in organizations. Digital transformation is a managed approach that refers to "the increasing adoption of digital tools and technologies by an organization to fundamentally alter both its internal and external processes and functions" (Bonnet and Nandan 2011, p. 2). However, in the organizational context digital transformation usually has a clear purpose or 'Value Proposition' that is added as pointed out by Wade and Marchant (2014, p. 2) who define digital transformation as "organizational change through the use of digital technologies to materially improve performance" (see also Gimpel and Röglinger 2015). Digital transformations are built on a foundation of digital technologies to realize business benefits. This differentiates digital transformations from other business transformations like turnarounds, post-merger integrations or re-organizations.

But the current practice is that digital transformation programs focus too much on technology (Bonnet and Nandan 2011). Such a technology-centric approach often fails to challenge the fundamentals of a company's business model. One reason is that this approach aims at automating existing business processes rather than attempting to fundamentally reengineer them to enable new business models. In addition, technology-focused transformations often alienate IT from the business functions, resulting in a significant resistance to change (Bonnet and Nandan 2011).

Organizations are investing in digitization without trying to push the necessary changes. They underestimate the organizational implications and the *people dynamic* of digitization—the need of aligning people, processes, organizational structures and culture. As Prof. Raffi Amit at Wharton emphasizes, "It is not technology that is the obstacle to digital transformation, it is people" (cited in Bonnet and Nandan 2011, p. 8). Two studies on the major challenges and hurdles of digital transformation programs are in support of this assumption (see Table 1).

The first survey conducted by the MIT Sloan Management Review and Capgemini Consulting in 2013 focused on the question why most organizations

Table 1 Major hurdles to realize the benefits of digitization

The biggest challenges for digital transformation programs. . .			
Study 1: MIT Sloan Management Review and Capgemini Consulting (Fitzgerald et al. 2013)		Study 2: McKinsey & Company (Bughin et al. 2015)	
1. No sense of urgency	*39 %*	*1. Lack of internal leadership or talent for digital projects*	*31 %*
2. Not enough funding	33 %	2. Lack of data and understanding of how digital trends affect [. . .] competitiveness	25 %
3. Limitations of IT systems	30 %	*3. Inability to keep pace with faster speed of business under digital*	*25 %*
4. Roles and responsibilities are not clear	28 %	*4. Inability to adopt an experimentation mindset that is key for best practices*	25 %
5. Lack of vision	28 %	5. Lack of dedicated funding for digital initiatives	24 %
6. Unclear business case	27 %	6. Misaligned or competing interests between digital projects and traditional businesses	23 %
7. Business units implementing independently in silos	24 %	*7. Lack of senior-management involvement or desire to change current practices*	*21 %*
8. Culture not amenable to change	*19 %*	8. Lack of technology infrastructure and insufficient IT systems	21 %
9. Lack of leadership skills	*16 %*	*9. Organizational structure not designed appropriately for digital*	*20 %*
10. Regulatory concerns	9 %	10. Business processes too inflexible to take advantage of new opportunities	19 %

Percent of respondents. Study 1: N = 1559 executives and managers. Study 2: N = 987 C-level executives
Italic text indicates People and organizational related challenges

struggle to realize the business benefits of digitization (Fitzgerald et al. 2013). It is interesting that half of the resulting challenges can be related to people and to the organizational aspects of digital transformation programs. The most important obstacle to digital transformation cited by the participating executives is a lack of urgency ('burning platform'). According to this study, complacency affects more companies than any other organizational barrier revealed in this study. Other people and organizational related challenges are governance issues like unclear roles and responsibilities, a lack of vision, an organizational culture that is not amenable to change and a lack of leadership skills.

A second and more recent study was conducted by McKinsey & Company in September 2015 (Bughin et al. 2015). The participating executives mentioned a variety of challenges that reflect the complexity and difficulty of implementing a successful digital program. As in the first study, half of the specific challenges could be linked to people and organizational issues implementing digital technologies. Lack of leadership and lack of digital talent (both functional and technical) top the list, followed by an inability to keep pace with the faster speed of digitization and the inability to adopt an experimentation mindset. Other challenges are a lack of senior-management involvement or of a desire to change current practices, then there is also an inappropriately designed organizational structure for digitization.

Both studies have in common that they demonstrate the high importance of people and organizational issues to be managed in digital transformation programs. The results provide sufficient empirical support for the assumption that it is people and organizational topics that are at the heart of any digital transformation program (see also Bonnet and Nandan 2011). As with all forms of business transformations, people need to be mobilized and engaged. Existing incentive and reward systems as well as organizational policies and structures have to be adapted to support new ways of working and collaboration. The technical nature of digitization often results in underestimating these fundamental levers of digital transformations. Digital transformation is first and foremost an enterprise-wide business transformation, and technology should rather be seen as second in order priority (Bonnet and Nandan 2011).

2.2 *Six Theses on Organizational Implications of Digitization*

The widespread deployment and adoption of digital technologies will have two major organizational impacts: Digitization not only changes ways of working; it also accelerates the speed of change organizations are facing. Both implications lead to three major requirements that have to be tackled by organizations in order for these to be successful with their digital transformation endeavors. Digitization requires new skills and competences; it calls for new forms of leadership, and it forces companies to build new organizational capabilities. To the degree that organizations fulfill these requirements and move quickly towards digitization, they will also evolve their culture (see Fig. 1).

The six theses on organizational implications caused by the deployment of digital technologies and applications will be described in the following paragraphs.

2.2.1 Thesis 1: Digitization Changes the Way of Working

Digital technologies and applications enable new ways of working within organizations as well as with customers and partners. For instance, the adoption of social media technologies (e.g., collaboration platforms, social networking, online video conferencing, blogs, wikis) has become quite a widespread in companies (Bughin et al. 2014). Their use has changed the way employees share information and knowledge, as well as how they collaborate and communicate (Bonnet and Nandan 2011). These tools offer lots of opportunities to leverage information in valuable

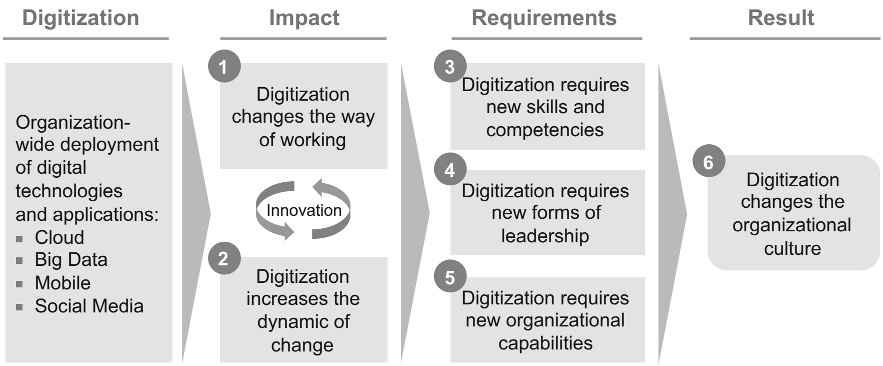

Fig. 1 Organizational implications of digitization

new ways, e.g., by accumulating and distributing knowledge, connecting employees to exchange information, and fostering innovation (McAfee 2009). In combination with mobile technologies (e.g., smart phones and tablets) these social media tools give employees an unprecedented level of flexibility in connecting to their work and to each other, i.e., 'anytime' and 'anywhere' (Harvard Business Review Analytic Services 2014). In addition, the interconnectivity of people through mobile and social technologies facilitates virtual work bringing internal and external experts together to support projects.

Furthermore, mobile and social technologies give employees new channels to interact with customers, suppliers, and partners. For instance, social networks can be used to listen and to better understand customer opinions concerning products, services, and the organization as a whole. These technologies can also be used for communicating with customers or for providing better customer services (Harvard Business Review Analytic Services 2014).

2.2.2 Thesis 2: Digitization Increases the Dynamic of Change

It is a shared observation that organizations everywhere are struggling to keep up with the accelerating pace of change (Kotter 2014). It is also a commonly made assumption that digitization is one of the main reasons why the speed of change is increasing (Bonnet and Nandan 2011; Brynjolfsson and McAfee 2011; Fitzgerald et al. 2013; Westerman et al. 2014). The use of new technologies in organizations is not a new phenomenon—what has changed is the level of connectedness, the accelerated provision of new digital capabilities, as well as the pace at which these technologies are being adopted by customers, employees, and organizations. Amongst others, the process of digitization has triggered new customer behavior, e.g., using mobile devices to get real-time access to competitive price tags or peer reviews on products using (see Ernst & Young 2011). This process is in turn having a profound impact on every industry and organization (Bonnet and Nandan 2011; Fitzgerald et al. 2013).

For example, cloud technologies and platforms provide shareable digital capabilities that enable organizations to scale business up and down a lot faster in response to demands than with on-premise solutions (Harvard Business Review Analytic Services 2014). Using cloud technologies, organizations will be more agile, and flexible to meet changing customer expectations (Iyer and Henderson 2010). In addition, cloud technologies help organizations to create new business models and services as well as to adapt business processes to new requirements at a higher pace than in traditional IT environments (Harvard Business Review Analytic Services 2014).

Another example for increasing the speed of change in organizations is the availability of new analytic technologies (such as analytical engines running on big data). Today, organizations have the ability to integrate, process and analyze large amounts of structured and unstructured data in real time. This gives them the opportunity to generate real-time, predictive and prescriptive analytics that help business to accelerate decision-making and innovation processes (Davenport 2014; Harvard Business Review Analytic Services 2014).

Both the new ways of working and the increased pace of change induce new organizational requirements and capabilities to cope with the constant pressure to adapt.

2.2.3 Thesis 3: Digitization Requires New Skills and Competencies

It is a common belief that digitization fosters innovation and leads to productivity gains for organizations. However, without the 'human factor' it is not possible to realize these benefits. Only if employees are familiar with and able to use the digital technologies and solutions they can apply them correctly and so add value for the organization. Digitization requires a workforce with a digital skill set. It demands employees who are digitally savvy and have strong business acumen (McAfee and Welch 2013). They should think interdisciplinarily and be continuously in touch with and also go after the latest digital developments and technologies (Gimpel and Röglinger 2015). As digitization increases the speed and intensity of change, employees should also possess more fundamental competencies like dealing with complexity and increased tempo; they ought also to be resilient. But finding such people internally and even externally is difficult. The substantial shortage of digital talent has also been pointed out by a recent study on digital skills (Hoberg et al. 2015). According to this study, specific development programs targeted to reduce the digital skill gaps are rare and time consuming. But, "without the digital talent [. . .] ambitious visions for Digital Transformation may lack credibility or—worse—overarch the capabilities of the organization" (McAfee and Welch 2013, p. 38).

One example: organizations recognize the importance of big data for their business, but the benefits of big data can only be realized if enough employees dispose of specialized skills in advanced predictive analytics. Data analysts and scientists have the ability to understand both the statistical modeling and the business applications of big data, yet these are hard to find (Davenport 2014; Gottlieb and Willmott 2014). The lack of appropriately qualified employees turns out to be one of the biggest barriers to big data (Harvard Business Review Analytic Services 2014).

McAfee and Welch (2013) pointed out another challenge for organizations with respect to the availability of digital skill sets. Most organizations have employed people from different generations that have different levels of familiarity with digital tools (the so-called *generation divide*). Younger employees may be more familiar with digital tools and ways of working than their more tenured colleagues. In contrast to this, older employees may have some reservations about getting acquainted with digital tools or—if they are in management—are reluctant to decide on implement these. On the other hand, younger employees are often frustrated by the slow pace of deploying digital tools and their limited availability in the organization. This may also have a negative impact on the organization's attractiveness as an employer for digitally qualified talent.

To overcome skill deficiencies with new digital technologies and with new ways of working should be on top of the executive agenda. Organizations have to understand which skills and competencies they have today and which qualifications are going to be necessary in the next years. An ineffective rollout of training programs to train employees in new digital technologies and in ways of working is considered to be one of the key barriers for digitization (Bonnet and Nandan 2011). Therefore, investments in education and training in digital technologies are a key success factor for any digital transformation program.

2.2.4 Thesis 4: Digitization Requires New Forms of Leadership

Digitization enables and at the same time forces leaders to make continuous adaptations in the organization's strategy, business models, products or services, processes, technology, and structure—and this under *v*olatile, *u*ncertain, *c*omplex, and *a*mbiguous conditions. This rapidly changing business environment that has become the 'new normal' is called VUCA world (Horney et al. 2010; Johansen 2012). For example, it is clear that cloud computing will allow organizations to outsource their IT capabilities to third party providers, that much more people will have access to shared resources in the cloud through mobile devices, and that IT functionality can be deployed faster (Iyer and Henderson 2010). But it is unclear what kind of new forms of connections, collaboration, and business will arise in a future based on cloud solutions (Johansen 2012). Digitization exerts pressure on leaders in a VUCA world demanding more leadership flexibility, risk-taking and speed in decision-making (Horney et al. 2010).

However, a significant challenge for most organizations today is that they have traditional decision-making processes based on well-designed hierarchies. Leaders were socialized in traditional management systems not well adapted to the VUCA world and the accelerating speed of change caused by digitization. The hierarchical structure of organizations and of 'silo thinking' often both lead to decision-making processes too slow for dealing with the cross-functional, technological and rapid nature of digital transformation (Bonnet and Nandan 2011).

Moreover, the implementation of digital tools, the automation of business processes and the role played by big data in decision-making increase the level of transparency in an organization (McAfee and Welch 2013). For instance, the widespread availability and use of social platforms for internal discussions and knowledge exchange make information easily available for a large number of employees. Digitization results in the free-flow and democratization of information, bypassing any management level (Bonnet and Nandan 2011). Managers—especially midlevel managers—may see this loss of control as a threat to their leadership role and might therefore react by resisting digitization. At the same time these managers have to support the technology-enabled change process, they have to translate the digital vision into day-to-day operations and to mobilize their employees (McAfee and Welch 2013).

As digitization affects all levels and areas of an organization, the role of leadership is of paramount importance for the transition process. Capturing the full benefits of digital technologies, managers have to challenge the way their organization operates. They have to engage their employees in a process of redefining how they work and what the organization does (Westerman et al. 2014). A leadership attitude that is open to dealing with the challenges of digitization and to accepting its effects on leadership roles including one's own will be crucial to the success of any digital transformation initiative.

2.2.5 Thesis 5: Digitization Requires New Organizational Capabilities

Closely associated with new forms of leadership are the organizational capabilities that are needed to increase and sustain organization wide digitization efforts. Many organizations have started to establish new governance structures and digital roles like innovation committees, or introducing a Chief Digital Officer (CDO) to lead digital transformations (Tannou and Westerman 2012). For example, the CEO of Allianz recently appointed a high-ranking manager as CDO to lead a newly formed digital transformation team and the digitization process of the company. However, digitization can't succeed simply by adding elements such as these to the existing structure, thereby increasing the overall pressure to make changes within the organization (Dörner and Meffert 2015). The challenge is to establish an organizational structure that is agile, flexible, and collaborative to a sufficient degree, while keeping the rest of the business running smoothly (Desmet et al. 2015). Organizational agility is seen as, "an essential requirement for being successful in the fast-moving digital world" (Gimpel and Röglinger 2015, p. 14). But as Kotter (2014, p. 1) clearly states, "any company that has made it past the start-up stage is optimized much more for efficiency than for strategic agility." Thus, especially large and mature organizations are those that struggle to become more agile in facing the challenges of digitization.

Organizations need a capability to be simultaneously stable (resilient, reliable, and efficient) and dynamic (fast, nimble, and adaptive) (Aghina et al. 2015). This is best organized by means of combining a management-driven hierarchy with a flexible network to form a dual operating system (Kotter 2014). The coincidence of 'Operational Excellence' (i.e., stability) and disruption (i.e., agility) also leads to new ways of working, collaboration and thinking in organizations. For instance, if business models and/or processes have to be adapted quickly according to new customer demands, small teams that are integrating various business functions have to be set-up to apply agile development methods to build new products or services as prototypes, and to then test and adapt them based on feedback, often within days or weeks (Desmet et al. 2015). Cross-functional teams need visible top-management support, a clear mandate to get things done (see also decision making processes above), and sufficient resources to develop a program, as well as profit-and-loss responsibility and accountability. Key performance indicators have to be adapted to monitor all customer interactions with the brand across all channels (i.e., the entire customer journey) rather than for just single channels or products. Finally, performance incentives should reward the successful delivery of such holistic customer journeys (Dörner and Meffert 2015).

2.2.6 Thesis 6: Digitization Changes the Organizational Culture

According to a recent McKinsey study (Bughin et al. 2015) organizations with a strong digital performance also possess an organizational culture that encourages risk taking. Digitization requires a different mindset than the one required for previous waves of transformative technology (Fitzgerald et al. 2013). It will allow a far more transparent information flow throughout the organization; new information flows leading to improved knowledge sharing, collaboration, and decision-making (Westerman et al. 2014). In addition, Gimpel and Röglinger (2015) pointed out that management has to be open for the needs and opportunities of digitization and to establish such a digital mindset throughout the whole organization and at all hierarchical levels.

For instance, with respect to big data, successful organizations are those that adopt a corresponding big data culture. This kind of culture is described by Davenport (2014) with several attributes: Impatience with the status quo and a sense of urgency, a strong focus on innovation and exploration, a strong belief in technology as a source of disruption, a culture of commitment, and a non-hierarchical and meritocratic organization. However, aligning the existing corporate culture with new digital realities will be difficult and is considered to be one of the main challenges in the digital transition of organizations.

According to Schein (2010) organizational culture is a complex concept that embraces three different levels: The first level refers to artifacts that are visible and sensible such as office buildings or spaces, observed behavior as well as the organizational processes or structures. The second layer describes espoused values that are less visible such as shared beliefs on standards, norms or rules of conduct. Finally, the third and deepest level has to do with the basic underlying shared assumptions of an organization. These are unconscious, taken for granted beliefs, perceptions, thoughts, and feelings that are the ultimate source of values and action (Schein 2010). Organizational culture can only be understood by analyzing all three layers. Changing the organizational culture will be difficult because it is this culture that provides meaning to employees and makes life more predictable to each one of them. Any attempt to change a company culture therefore leads to anxiety and resistance to change (Schein 2010).

For example, an organization could have the basic assumption that time is money and that this is needed to improve quality, accuracy, and efficiency. This shared belief drives norms, values and the behavior of management and employees. It is very likely that digital initiatives requiring risk-taking and having an unpredictable outcome may face resistance. Digitization will be far more successful if an organization's culture is driven by the shared assumption that time creates room for organizational autonomy and experimentation. Visible signs of such an assumption on the level of artifacts might be flexible office spaces that can be quickly assigned to project teams or the widespread availability of Design Thinking environments.

It is important to note that leadership is crucial in starting to create a culture and has to also manage and sometimes change it (Schein 2010). Digitization requires new forms of leadership, skills and organizational capabilities that have the potential to evolve an organization's culture towards a culture that is more open for technology driven innovation.

3 Managing Organizational Change in Digital Transformation

Organizational change management is a critical success factor for any digital transformation program (Bonnet and Nandan 2011; Dörner and Meffert 2015; Gimpel and Röglinger 2015; Hoberg et al. 2015; McAfee and Welch 2013; Westerman et al. 2014). Organizational change management is defined as the application of specific interventions to support the transition of an individual or group from a current to a desired future state. It deals with the people who have to change their way of working and thinking because of digitization. Change management methodologies and practices can help in overcoming some of the major obstacles to benefitting from digitization, obstacles such as lack of a digital vision, deficiencies in digital skills, limited involvement of leadership and employees or misaligned incentive systems (see Fig. 1).

The digital transformation of an organization is a process that requires a managed approach embracing all employees. However, as pointed out by McAfee and

Welch (2013, p. 37), "making new digital ways of working stick is a matter of winning the hearts and minds of people at all levels in the organization." An organizational change management embedded in a digital transformation program can help to get the necessary levels of buy-in and engagement for the digital transformation initiative.

In general, supporting large-scale business transformation programs with proven change management methodologies and tools is nothing new. The question is whether these methodologies have to be adapted to meet the specific requirements of digitization. According to McAfee and Welch (2013) many of the traditional change management concepts and tools still apply to digital transformation. Digital tools offer new opportunities for delivering change management. They help to connect with employees on a large scale and in new ways. For instance, blogs provide a forum for sharing perspectives and collecting feedback, videos help to create a richer, more personal executive communication, social platforms give employees the opportunity to share their ideas, collaborate with colleagues and make their contributions transparent (McAfee and Welch 2013).

Yet leveraging digital tools to support organizational change is only one of many opportunities digitization has to offer. As digitization is accelerating the pace of change and the way of working tremendously (see above) it can be assumed that the way of delivering change management has to be adapted to meet the needs of digitization. For example, a well-known approach to change management is the eight-step process of leading change introduced by John Kotter in 1996. Kotter recognized that the world is changing at a far quicker pace than in the early 1990s and that this rate of change is now ahead of the ability to manage it. His conclusion lay in an update of certain aspects of his change management approach so as to be effective in today's environment (see Kotter 2014). Table 2 identifies four key differences in how to lead change today versus 1996 (Kotter International 2016).

The proposed organizational change management approach considers the changed requirements of digitization and embraces four major areas that are outlined in the following paragraphs (see Fig. 2).

Table 2 Key differences in leading change today versus 1996

Leading change: 8-step process (1996)	Accelerate: 8-step process (2014)
• Respond to or affect episodic change in rigid, finite, and sequential (step by step) ways	• Run the steps concurrently and continuously
• Drive change with a small, powerful core group	• Form a large volunteer army from up, down and across the organization to serve as the change engine
• Function within a traditional hierarchy	• Function in a network flexibly and agilely outside of, but in conjunction with, a traditional hierarchy
• Focus on doing one new thing very well in a linear fashion over time	• Operate as if strategy is a dynamic force by constantly seeking opportunities, identifying initiatives to capitalize on them, and completing them quickly and efficiently

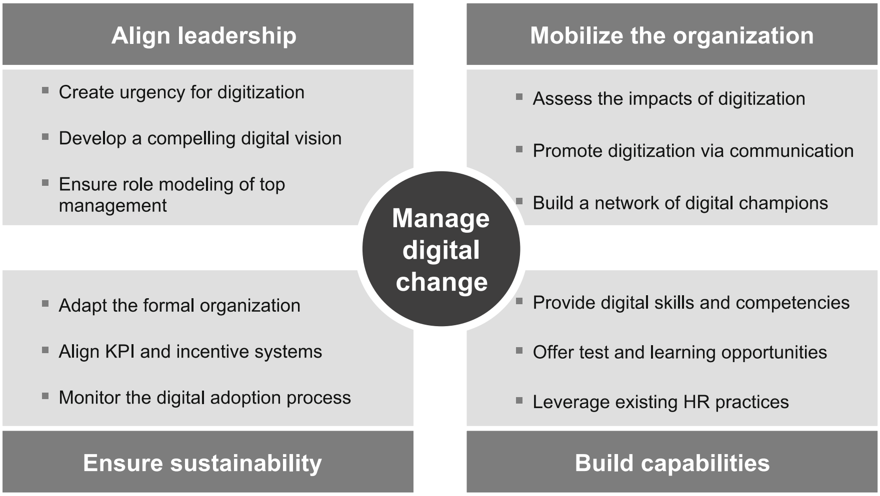

Fig. 2 Organizational change management approach for digitization

3.1 Align Leadership

Aligning leadership on digitization is the most important area in a digital transformation program and is the necessary basis for organizational change.

3.1.1 Create Urgency for Digitization

A first step in managing digital change is the creation and maintenance of a sense of urgency around digitization. Urgency means that, "a significant number of people wake up each morning and have, somewhere in their heads and hearts, a compelling desire to do something to move the organization toward a big strategic opportunity" (Kotter 2014, p. 112). Digitization is such a big opportunity. However, complacency, being the opposing orientation, affects many organizations and is seen as a major impediment to digital transformation (Fitzgerald et al. 2013). Complacent people see no reason why they should change anything. Moreover, they have the tendency to filter any information that is not consistent with their own view on how things should be done. They are basically focused inward and do not perceive either the opportunities or the threats digitization brings to their business. A good example for how complacency can endanger the existence of a whole company has been described by Lucas and Goh (2009) with Kodak's response to digital photography.

One strategy for overcoming complacency and building a true sense of urgency is to "bring the outside in" (Kotter 2014). This can be done by reconnecting the internal reality with external risks and threats but also with new opportunities related to digitization, e.g., digital use cases. It is also helpful to communicate information about what some managers and employees have already done to move towards digitization. Another powerful strategy for enhancing open-mindedness in complacent people is role modeling by leadership (see below).

3.1.2 Develop a Compelling Digital Vision

Aligning leadership implies the question what it is that is to be aligned. A digital transformation needs a vision. Such a vision is seen as a critical pre-requisite to align leadership around an organization's digital future and to drive the digital change throughout the organization (Bonnet and Nandan 2011; Fitzgerald et al. 2013; Westerman et al. 2014). A digital vision is usually formulated by top-level-management and has to be shared by the senior leadership team. Without a common vision for change, leadership and employees tend to carry on with 'business as usual', even if this is no longer useful in the digital world (Westerman et al. 2012).

The quality of the vision is important. A holistic digital vision should clarify why change is necessary, how to proceed and how the future will be better than the current situation (Westerman et al. 2012). Employees have to feel they are part of this vision and that it meets their needs. The vision must help them understand whether and in what ways they are to change their behavior and what they can change on their own. The translation process from such a digital vision to operational and tangible objectives has to be done by the senior executives. However, formulating a compelling digital vision is challenging. The high speed of technological developments makes it difficult for leaders to anticipate the future state of a digitalized organization.

3.1.3 Ensure Role Modeling of Top-Management

Top management commitment is seen as a critical success factor in digital transformation programs (see Fig. 1). The CEO should take charge and become the principal advocate in support of the transformation program (Bonnet and Nandan 2011). One powerful way to demonstrate this commitment is role modeling (Kotter 2014). For instance, senior executives should be seen using digital technologies and should share their experience with the organization. They should initiate and join conversations frequently. This can help to reduce the gap between senior executives and front line staff and result in more authentic leadership and role modeling. They should celebrate any digital opportunity seized demonstrating movement towards digitization. In digitalized organizations, many executives are active bloggers, podcasters and Twitter users or are using social platforms (e.g., SAP® Jam) to communicate with their organizations on digital topics. In doing so, they are leading by example and setting expectations for the rest of the organization (McAfee and Welch 2013). Therefore, an effective change management strategy should try to leverage role modeling with as many mechanisms as possible, as often as possible, and involving as many people as possible. Successful role modeling means that over time other people start to think and act like the role model (Kotter 2014).

3.2 Mobilize the Organization

Increasing awareness for digitization and setting the direction is necessary but not in itself sufficient for successful digital transformations. It is also necessary in setting the entire organization into motion towards digitization.

3.2.1 Assess the Organizational Implications of Digitization

Organizations need a better understanding of how digitization is changing their business environment and where it is having the greatest impact on their current organization (Westerman et al. 2014). They have to know to which degree their business models, processes and interactions with customers have to change and which ones will continue to be effective in a digital world. A traditional change management tool is change impact analysis. It helps to identify the organizational implications of a business transformation for different stakeholder groups (Kohnke et al. 2012).

Another useful tool to get a better understanding about the change impacts of digital technologies is the customer journey map (Knowledge@Wharton 2015). It describes, "the customer's expectations, experiences and reflections as it unfolds over time across multiple stages and touch points while using a product or consuming a service" (Knowledge@Wharton 2015, p. 4). A customer journey map describes the as-is situation and helps converting it to a desired to-be situation that improves the customer experience. Focusing on the customer journey helps to ground the digital transformation in the practical realities of change by maintaining a strong customer orientation (Dörner and Meffert 2015). It is important to note that a customer may also be an end user, a stakeholder or partner.

After mapping the customer journey from beginning to end, organizations can focus on how the rapidly evolving digital technologies—analytics, mobile, social and cloud solutions—can make touch points better, faster, and more efficient (Dörner and Meffert 2015). With customer journey maps, organizations are able to better visualize which aspects of their business should continue, which of the new technologies should be embraced, and what new business models they can create. Furthermore, the customer journey map can be used for communication measures to make the required changes more comprehensible and tangible for the affected employees. Therefore, in addition to a traditional change impact analysis, the customer journey map is a good source for communication content.

3.2.2 Promote Digitization via Communication

A digital transformation will only be successful if the entire organization understands the needs and opportunities of digitization. Like in other business transformation programs, developing a communication plan and delivering targeted communication are important steps for promoting digitization throughout the organization. Effective communication always connects with people's feelings and with what they find meaningful (Kotter 2014). The digital vision and the identified change impacts are important sources for raising the awareness and increasing acceptance for the digitization efforts.

In addition to traditional forms of communication (e.g., information events, email newsletters, or print media) communication activities should leverage digital tools as often as possible. Management can use a wide array of digital channels, such as broadcast, web, video, and social networks to generate continuous two-way communication at scale (Westerman et al. 2012). The usage of digital tools can help to mobilize and align the employees on digital objectives by building awareness, creating transparency, and establishing open channels of communication (Bonnet and Nandan 2011). Digital tools also provide an excellent platform to engage stakeholders in change management activities like decision-making and problem-solving. For example, employees should be encouraged to identify new work practices and digital opportunities that will advance the digital vision, e.g., by launching specific innovation campaigns or innovation competitions (Westerman et al. 2012).

3.2.3 Build a Network of Digital Champions

In order to scale the mobilization efforts and to further promote digitization throughout the organization, it is important to identify those people who are enthusiastic and open to digitization and willing to help (Westerman et al. 2014), viz. digital champions. These people are important to connect the top-down digital transformation with the various business functions, regions and departments. Such a network of digital champions forms part of the change management strategy to mobilize the organization. The identified digital champions can also facilitate the knowledge transfer to other employees (McAfee and Welch 2013).

The network acts as a communication conduit between the business and the digital transformation project, facilitating two-way communication with message updates and feedback on impacts and project perceptions. It is used to generate awareness of the impacts of digitization on the different business areas. The network will support the management of change issues on the ground while providing feedback to the relevant project leadership and change management team.

3.3 Build Capabilities

In addition to creating awareness and mobilizing the organization for digitization it is also important to enable the employees to use digital technologies and applications and to leverage them for developing new digital business models.

3.3.1 Build Digital Skills and Competencies

Successful digital transformation is built on a foundation of core skills and capabilities (Westerman, et al. 2012). Only if employees are able to use digital technologies and applications, can the benefits of digitization be brought about. However, the right digital skills and competencies are not widely available in today's organizations (Bonnet and Nandan 2011; Hoberg et al. 2015). Therefore, it is necessary to assess target group specific training needs. The key questions are: what digital skills are currently available, which skills require specific digital transformation programs, and which skill gaps have to be filled (Westerman et al. 2014). On basis of the identified skill gaps a training strategy has to be developed to ensure that the right skills and competencies are built up in the organization. Training programs have to focus especially on employees who are not technology-affine, e.g., older generations (generation divide), and they should offer a broad range of curricula to cover all technologies and applications related to digitization. Moreover, the training content should also embrace methods to develop digital business models (e.g., business model canvas) or to focus on the customer experience and desirability of new products and services (e.g., Design Thinking). Such a training program should build on a mix of different training methods, like traditional classroom training, eLearning, and peer-group learning groups. Formal certification could help to increase the attractiveness and value of such training programs.

3.3.2 Offer Test and Learning Opportunities

Another powerful way of building the necessary skills and to drive behavioral change is to offer test and learning opportunities for employees. An effective training program should leverage the possibilities that digital tools offer for new ways of training delivery, e.g., provide virtual, innovative learning environments, where employees are able to experiment with new ways of behaving. By using new digital technologies in such a risk-free setting employees will better perceive the change and understand what it means for them. The emotional experience is essential for the learning success.

Furthermore, employees should—wherever possible—be actively involved in the digital transformation process. For instance, they should get the opportunity to work on new digital concepts, test their ideas with customers and iterate them until they get it right. Design Thinking is an effective approach to promote such a new way of working and thinking in the organization (Brown 2009). With this approach, organizations avoid overly deterministic specifications, market research that misses the point, and long planning cycles that end up producing something customers don't want (Dörner and Meffert 2015). Senior managers could be assigned to projects together with digitally savvy employees to mutually work on the possibilities of digital technologies and applications to offer (McAfee and Welch 2013).

3.3.3 Leverage HR Practices

In addition to developing new training programs to up-skill the workforce on a larger scale regarding digitization it may also be important to liaise with HR to leverage existing HR processes like recruiting and talent management processes. For instance, skill gaps could also be filled by hiring experienced people to coach employees in digital technologies or by partnering with software vendors or other suppliers (if possible) to gain the appropriate skills (Westerman et al. 2014). Another possibility is to pair young new employees who are digitally adept with senior managers and executives to convey digital knowledge in the sense of a digital reverse-mentoring program (Westerman et al. 2014). HR could set-up a 'digital skills inventory' with associated proficiency levels for specific roles and career paths (McAfee and Welch 2013). Such an inventory facilitates the overall skill management process for the entire organization and supports a strategic HR workforce planning with respect to digital talent.

3.4 Ensure Sustainability

As with other large-scale business transformations there is the risk of digital transformation initiatives failing to achieve their objectives because of their losing momentum. It is necessary to make the change 'stick' by establishing effective mechanisms to sustain and monitor the digitization process.

3.4.1 Adapt the Formal Organization

As stated before, digitization requires new organizational capabilities. Especially necessary is the capability to cope with the increasing pace of change. Organizations have started to experiment with different formats to adapt their organizations to the digital challenges, e.g., virtual laboratories where applications and methods can quickly be put into 'proof-of-concept' pilots, cross-functional task forces or innovation boards (Bonnet and Nandan 2011). Some organizations established formal, dedicated roles, e.g., chief digital officer (CDO) for regions and at board level to drive digitization. People in those roles liaise with central digital units to align top-down digital strategies with regional requirements (McAfee and Welch 2013).

These organizational enhancements can promote digitization and increase the speed in decision-making and agility—but only up to a certain degree (Kotter 2014). Kotter proposes a dual operating system that consists of a traditional hierarchy and an additional network structure. The network copies organizations in their early stages, e.g., their start-up phases, before developing any organizational chart, management levels, formal job roles or reporting lines. Such a network is flexible, dynamic and—most important—liberates information from silos and hierarchies and enables it to flow with far greater speed (Kotter 2014).

3.4.2 Align KPI and Incentive Systems

After adapting the formal organization to support fast moving digital change, it is also necessary to align the KPI and incentive systems to sustain this process (Westerman et al. 2014). It is difficult to change the organizational culture and individual behavior without incentivizing new ways of working based on digitization. Therefore, organizations should develop a high-performance culture around digital initiatives that will incite and foster digital work that challenges traditional ways of doing business (Bughin et al. 2015). However, organizations are struggling with respect to performance management systems adapted to digitization. According to a recent McKinsey study, <40 % of surveyed executives say their organizations have accountability measures in place for their digital objectives, either through measurable targets or by means of performance incentives for employees who are relevant for their digital programs (Olanrewaju et al. 2014).

Top-management has to translate the digital vision into a set of measures and targets to monitor the progress towards digitization and to drive the desired results (Bonnet and Nandan 2011). For instance, at senior levels, personal performance KPIs should be tied to digital transformation objectives and milestones to focus executive attention (McAfee and Welch 2013). Furthermore, such KPIs should be cascaded down through all hierarchical levels to ensure a broad support for digitization. This may be facilitated by goal setting systems.

In addition, boards can provide sufficient funding to reward behavior that supports digitization or bold decisions in fields digital in nature. For example, Siemens recently created an innovation fund of 100 Mio Euro to support digital initiatives. Innovation contests or other award programs can also be used to recognize individual contributions to digital transformation efforts. Moreover, non-financial rewards such as recognition, expertise or reputation can also be effective drivers for employee motivation to support the digitization process. For instance, organizations can try innovative approaches like 'gamifying' new digital tools by integrating game mechanisms into reward systems. Achievements and recognition can create a more engaging user experience (McAfee and Welch 2013).

3.4.3 Monitor the Digital Adoption Process

Lack of adoption is a serious concern in the context of digital transformation. Monitoring measures should focus on behavior (i.e., using the digital tools) and not just on having these tools. Hence, KPIs should be applied to measure actual user behavior and not in terms of how widely available or feature-rich the digital tools are (McAfee and Welch 2013). System-related KPIs can be monitored to analyze the frequency and intensity of using digital tools or applications. Another aspect is related to the measurement of the general diffusion of digitization within an organization. For instance, indicators could be defined to measure the digitization of current business models and processes.

However, usage behavior is also driven by individual intentions and attitudes towards working with digital technologies and applications. Other methods are required to capture these aspects. Organizational change management methodologies usually embrace a broad range of change monitoring methods, such as change readiness surveys, sounding boards or interviews to assess the opinions and beliefs of employees. Surveys can also be time consuming and expensive—especially when large groups of employees have to be involved. Sometimes organizations face a tendency to 'over-survey' their staff. Applying digital technologies like big data analytics may reduce the number of surveys applied in change management. For instance, consent analysis to capture feedback after a communication campaign or any kind of change initiative may replace traditional surveys. A pre-requisite is the widespread use of digital technologies such as social media in the company. Data flows within the company could constantly be monitored and analyzed. However, questions of data protection and anonymity have to be considered.

4 Organizational Change Management in a Digital World

In general, major digital transformation programs are not very different from other large-scale business transformations. They also require elements like a roadmap, a project and resource plan, a project organization or an organizational change management to drive the change. An obvious difference to traditional change management approaches might be the usage of digital technologies and applications to support the change management activities, such as mobile or social platforms for communication purposes or big data and consent analysis to capture the organization's perception on a change initiative. Why shouldn't an avatar explain the results of a change survey to an employee and give a personalized feedback in the future? The technological progress offers new opportunities to digitalize the change management methodology itself. The application of new digital tools can make digital change more meaningful and sustainable (Ewenstein et al. 2015). Nevertheless, this is rather a short-term view on how change management will be evolving during the next years. Seen from a longer term perspective the importance of traditional change management will decrease as organizations advance with their digital maturity. Technology-enabled change will emerge on a constant basis. It will happen everywhere in the organization in a more decentralized way and in incremental steps rather than 'a one-time movement from A to B, from one static state to another' (Laloux 2014, p. 215). The digitization process makes large, disruptive technology-driven transformation programs obsolete—just as it does the full arsenal of a traditional organizational change management methodologies (e.g., linear phase models, step-by-step approaches or checklists). These approaches seem too static and deterministic be suited for the tremendous speed of change caused by digitization.

Digitization will not only have consequences for the change management methodology, it will also change the role of the change manager. During the digital transformation process the tasks and responsibilities of internal or external change management expert will remain the same. But they will need profound knowledge of digital technologies. In the long term, the tasks of change management professionals will probably be more specialized and focused (e.g., coaching, supervision, dealing with resilience) because the management of change will be broadly embedded in the organization and supported by managers, employees or even tools.

Digitization is not just about technology. It affects all employees and the entire organization. To be successful, it is important to manage the digital change in a thorough way during the transition period and to build organizational capabilities to embed change management skills and competencies throughout the organization.

Key Learnings

- Digitization has a strong impact on ways of working and accelerates the pace of change organizations are facing. These two major implications call for new skills and competencies, new forms of leadership and organizational agility, which in turn will evolve the organizational culture towards a digital mindset.
- The realization of benefits associated with digitization is highly dependent on how these people and organizational aspects are managed and it highlights the importance of organizational change management as a critical success factor.
- The organizational change management approach needs to be adapted to be effective in today's ever changing environment caused by digitization.

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Dr. Oliver Kohnke is chief business consultant at SAP's Business Transformation Services and global change management practice lead. Having joined SAP in 2002 from McKinsey, he has spent over 20 years managing the people side of projects. His focus lies on change management, technology acceptance and innovation. Oliver holds a Ph.D. in business and organizational psychology and is an associate professor ("Privatdozent") for organizational psychology at the University of Mannheim, Germany.

Antithetic Leadership: Designers Are Different, Business People Too

Michael von Kutzschenbach, Peter Mittemeyer, and Werner Wagner

Abstract Many established business models are being revolutionized by huge strides in IT development, the availability of cheap money, and the emergence of new buyer groups. To address these new paradigms, companies need to establish a permanent *innovation capability* that goes far beyond existing research and development (R&D) and idea management. Innovation capability, often also referred to as *(business) innovation*, complements a company's *transformation capability*, which remains vital. To survive and remain competitive, companies must master both capabilities and the underlying logic in parallel. We use the term *antithetic leadership* to describe this duality in management behavior. This concept distinguishes between two areas of management logic: *business* (business transformation and operation) and *design* (ideation and innovation), each of which has its own theories and entrenched culture. Antithetic leadership is not an additional variant of cooperative leadership, but is rather the deliberate and purposeful practice of contradictory leadership in the same ecosystem at the same time, if necessary, by the same leader. To demonstrate what is happening in this inspiring new area, we will look at a consulting unit of SAP: The Business Transformation Services (BTS) group is facing the challenge of cultivating antithetic leadership, namely finding a way for both management cultures to relate, and enabling a positive exchange of ideas. Until now, the management culture of this group followed purely business logic.

M. von Kutzschenbach
Institute for Information Systems, University of Applied Sciences and Arts Northwestern Switzerland (FHNW), Basel, Switzerland
e-mail: michael.vonkutzschenbach@fhnw.ch

P. Mittemeyer
SAP Business Transformation Services (BTS), SAP (Schweiz) AG, Regensdorf, Switzerland
e-mail: peter.mittemeyer@sap.com

W. Wagner (✉)
SAP Business Transformation Services (BTS), SAP Deutschland SE & Co. KG, Walldorf, Germany
e-mail: werner.wagner@sap.com

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1 Introduction

It's not unusual for a new trend to cause a stir in management circles, but the hype generated by *innovation* is reaching seismic levels. In much the same way as continuous *growth* or *digitalization*, it is being hailed as a remedy for all ills, and managers everywhere are keen to stock their medicine cabinets with this new wonder drug. Whether as a precaution against disruptive business models deployed by the competition, or as a cure-all in the never-ending battle against falling margins, innovation is being prescribed by managers across the board and around the world, making it a duty of every employee to critically assess existing business practices.

In this chapter, we'll explore the current challenges companies are facing in the field of ever-increasing demand for innovation, and we'll introduce and discuss a new management style: antithetic leadership. Above all, we want to explore the revered concepts of ideation and innovation management[1] and find out what they really mean for managers and employees. Innovation is more than just a call to invent and keep reinventing. Creativity is an intrinsic human trait and mankind has been striving to continually improve and refine since history began. Management theorists have understood the significance of innovation for many years, going back to when Josef Schumpeter popularized the phrase 'creative destruction'. So why the furor about innovation now? What has changed? What has prompted this call to action and what does it mean?

2 Filling the Vacuum

The great expectations for innovation as a new, additional core capability in all companies are generated by several factors that create a powerful force in business systems that draws in customers and consumers, with the result that innovation can no longer be managed as simply business improvement. Companies must constantly redefine themselves through forward-looking re-imagination.

Looking back over recent years, we can trace this explosive progress to three significant developments:

- Rapid advances in the development of information technology, including Big Data, cloud computing, and the Internet of Things, to name but a few.
- Cheap money as a result of fiscal stimuli to alleviate the financial crisis, with business cases becoming a hollow gesture.
- The growing purchasing power of a billion-strong middle class in developing countries.

[1] *Innovation* is used here as a collective term for the stages of ideation and innovation management. See also Table 1.

All this means that companies around the world are desperately searching for ways to massively expand their top-line growth. Yet the entrenched engineering mind-set that remains prevalent in R&D departments can't cope with the fleeting nature of trends and ever-shorter product life cycles.

Companies need to rethink their business models to consolidate their competitive position. Simply providing new products and services does not set you apart from the competition. You can optimize existing processes and business relationships; however, if your business model remains essentially unchanged, it is unlikely that you will achieve the desired impact of your innovations. And it gets even tougher than this. While business models have changed gradually and over decades in the past, the permanent check and conversion becomes a necessity now, based on the creative power of the entire organization. Innovation is too important to be left only to the researchers and developers. Established business models have plenty of untapped 'quicker-higher-different' potential, waiting to be discovered and converted into market success. In business transformation, that is, the structured approach to organization development of products and services, which also includes the program-based realization of projects (with budgets, assignments of resources and deadlines, and a clearly defined target outcome), creative input is largely limited to the early stages. Business innovation, however, where design[2] logic comes into play, demands that you constantly question all factors, without exception, that influence the provision of products and services. Design logic must have a place alongside business[3] logic, with its focus on planning and controlling the production and marketing of products and services.

Design logic and business logic have different objectives, and meeting these objectives requires different and sometimes conflicting frameworks. This inevitably causes friction within the corporate culture and in the relationships between employees and management. The anarchic character of the early design stage sharply contrasts with the predictability and clarity dictated by business logic for the production and sales process; all participants must be able to handle this paradox in their day-to-day work. Managers and employees alike need to realize that a one-track corporate culture based on a single management philosophy is unlikely to succeed in the long run. To have even a hope of realizing the true innovation potential of a company, design processes must be managed differently than, yet concurrently with, business processes.

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[2] *Design* in this context is not just a concept or how something is formed; it explicitly includes all linear and non-linear ways of thinking and behavioral patterns, from ideation to a sufficiently detailed description of innovation. 'Sufficiently detailed' here means ready for implementation and scaling (→transformation). Design includes a range of aspects and goes far beyond just the physical form and color of an object or service. In particular, the designer also has to consider the function of an object or service and the interaction with the user.

[3] *Business* in this context is not simply manufacturing and marketing, but also includes all associated ways of thinking and behavioral patterns, from decision-making and implementation to delivery/handover or deployment by the customer. It is implicit that the objective is a financial one and is therefore subject to linear logical planning and activities.

3 An Example: The Business Transformation Services Consultancy Group at SAP

Antithetic leadership is relevant for all profit-oriented organizations. We will demonstrate how it can be implemented by using a consulting unit of SAP SE (SAP for short) as an example.

The Business Transformation Services (BTS) group includes more than 600 consultants worldwide, and advises strategic customers on which SAP® products to use and how. The consulting services BTS provides to SAP customers (advising on IT strategy and enterprise architecture) target the upper decision-making levels in these companies. To meet this objective, BTS has chosen an organizational form that aims to enable the highest possible added value for users of SAP products. Over the years, the BTS group has developed a finely-tuned business logic (see Table 1) to achieve this objective.

It now faces the challenge of providing customers with not only a business transformation service, but business innovation services as well. As SAP expands its portfolio to include open-solution products, such as its in-memory database technology SAP HANA® (formerly an acronym for High-Performance Analytics Appliance) and cloud solutions and the SAP HANA Cloud Platform, its customers want to know what added value SAP® solutions can provide on top of financially measurable improvements.[4] These new products may not be an immediate fix for an existing technical or business problem, but what they do provide is a massive opening in the scope and potential for new business ideas, which are different for each customer. In other words: rather than searching for a solution to fix a problem, we now have the solution and we're looking for a problem or a challenge that we can apply this solution to, perhaps an opportunity we've never even considered before. What SAP has to do now is identify potential new business areas for the solutions that are technically possible today. The future lies in complementing the traditional transformation business approach by identifying innovative business models and projects that ensure that customers remain competitive.

The stages involved in scaling a new disruptive idea in an existing company are described below (see Table 1).

Each stage requires quite different and even contradictory management approaches and corporate cultures.

In addition to the design stage (ideation and innovation management) and the transformation stage, the business model in IT consulting also includes an operation stage that involves deployment of the production application, and is not a subject of discussion in this example.

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[4]By this we mean new business cases.

Table 1 Understanding design and business stages

Ideation	• Ideation means the creative process of generating, developing, and communicating new ideas. We understand an idea as a basic element of thought that can be either visual, concrete, or abstract. Ideation comprises all stages of a thought cycle from generating and structuring ideas up to the decision on how to deal with it (detailed elaboration in the stage "innovation management", parking for later, trash bin)
Innovation management	• Innovation Management (IM) means the discipline of managing the maturation process of ideas in innovation. It includes a set of IM-specific tools and methodologies that ensures the selection of the most valuable ideas, based on their feasibility, desirability and viability. Importantly, innovation management is not relegated to R&D; it involves employees at every level in contributing creatively to a company's success
Transformation	• (Business) Transformation (BT) implies fundamental and complex changes within as well as across companies alongside the value chain. BT can be seen as structured approach to reach an agreed target state. It can also radically alter the company's relations with the wider economic and societal environment. This means, transformation is targeting more and more ecosystems, less concrete organizations. Examples of business transformation types are business process outsourcing, mergers, acquisitions or cross functional and (inter- and intra-) organizational restructuring
Operations	• Operations (or more specific, 'IT Operations Management') is generally agreed to encompass the day-to-day tasks related to the management of technology infrastructure components and the more granular needs of individual applications, services, storage, networking and connectivity elements of a total IT stack in any given deployment scenario. (Based on the definition of the CWDN—"The Computer Weekly Application Developer Network")

Source: Wikipedia (2015), unspecified and enhanced by authors

The specific challenge facing BTS is to encourage employees, managers, and the entire enterprise system, to use different skill sets in the ideation and innovation management stages than those used in transformation and operation stages. This is where a distinction has to be made between business logic and design logic (see Fig. 1).

Applying business logic to stages that actually belong to design logic (or vice versa) produces dysfunctional working environments and limits the potential (and usefulness) of your targeted results.

In today's companies, it is normal practice for managers, sticking with what they know, to simply apply business logic to innovation activities as well, without considering the implications. For example, they may set targets using clearly defined key performance indicators (KPIs), and failures to meet those KPIs are penalized. After all, this tried-and-tested, rational-technical approach has often proved successful when applied to new product developments in the past. However, when business innovation is introduced, the radical changes it brings about are quite different. In 2010, Liedtka and Ogilvie made a first attempt to systematize these two logics and show their distinct characters (see Table 2).

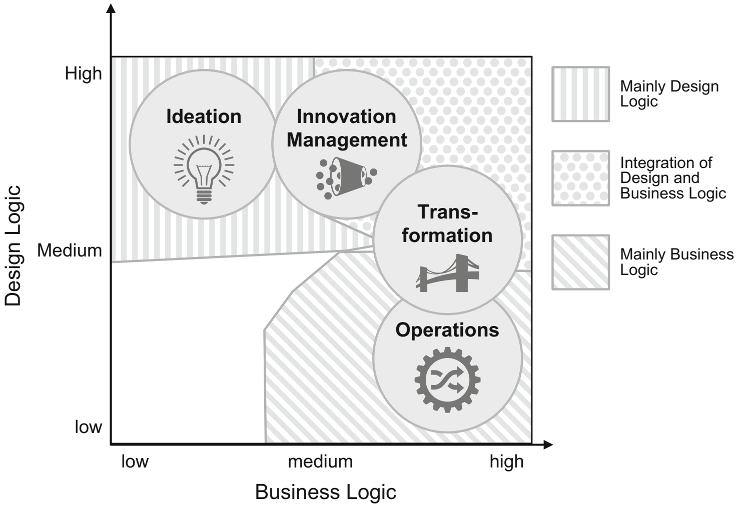

Fig. 1 Logical capabilities for managing a long-term, resilient organization

Table 2 Corporate cultures: business versus design

	Business	Design
Underlying assumption	• Rationality, objectivity; reality as fixed and quantifiable	• Subjective experience; reality as socially constructed
Method	• Analysis aimed at proving one "best" answer	• Experimentation aimed at iterating towards a "better" answer
	• "Trial and error"—For issues with a limited number of possible options	• "Fumble and stumble"—If the solution is imagined in the unobstructed space
Process	• Planning	• Doing
Decision drivers	• Logic; numeric models	• Emotional insight
		• Experimental methods
Values	• Pursuit of control and stability	• Pursuit of novelty
	• Discomfort with uncertainty	• Dislike of status quo
Level of focus	• Abstract or particular	• Iterative movement between abstract and particular

Source: Liedtka and Ogilvie (2011), enhanced by authors

Table 3 shows how this business-oriented comparison can be expanded to explain business and design mind-sets in day-to-day management and leadership. To optimize the results of employees given design tasks in a working environment of business-based logic, apply 'antithetic leadership' as described below.

Table 3 Key capabilities of antithetic leadership

	Business	Design
Leadership principle	• Command and control	• Encourage, moderate, request. And have patience
Career catalyst	• Achieve more with less	• Surprise and delight
Dominant corporate culture	• Individual performance, measurable in financial figures	• Team performance, measurable in problem solutions
Enablement	• High trainability, no significant cross-cultural hurdles, good repeatability with predictable results	• Contextual learning, cumbersome, results and speed very much depending on personal socialization and individual characteristics
Knowledge management	• Complicated, but manageable	• Complex, dependent on the 'terroir' of the surrounding ecosystem
	• Technology supported	• Social network is crucial ('inspire and share')

4 Antithetic Leadership: The Ideal Management Principle for a Design Team in a Business Environment

Antithetic leadership resists the temptation to apply one management style to both business and design challenges, and acknowledges the contradictory nature of the different necessities in the same ecosystem at the same time. There is nothing like a 'peaceful coexistence' of the two mind-sets: they are naturally fraught with tensions and need to be moderated, explained, appreciated and balanced permanently. A successful antithetic leader must be able to broker between the two worlds, switching ad hoc if necessary from one mode to the other. Antithetic leaders comply with requirements from both worlds and apply the specifics of each without losing the respect, credibility and reputation of their stakeholders. This leads to our conclusion that antithetic leadership is the most promising way to handle the frictions resulting from the two mutually repellent poles.

The antithetic leadership style in the BTS group has two main challenges: first, integrating BTS into the larger SAP organization, which continues to be controlled and managed by business logic principles. This applies to all supporting areas such as HR, Finance and Sales.

Second, protecting the reputation of managers who lead employees with design tasks and employees with business tasks at the same time. These managers have to make 'terroir'-specific decisions, which means that management issues are handled differently depending on whether they are business-related or design-related. From the outside, this distinction isn't always discernible, which can cause confusion and suggest a lack of consistency in management.

At BTS, the first step towards addressing these challenges was to remove consultants with a mind-set close to the design logic from their teams for the ideation and innovation management stages and place them in a separate SAP 'Business Innovation and Transformation' (SAP BIT) team. This created a protected environment, allowing BTS to try out design-specific management tools (including goal-setting and reward systems) and develop some basic principles that would help other units in the company with similar tasks. The idea of grouping employees into a team based primarily on their affinity with a particular mental logic, rather than their technical expertise, is itself an innovation at SAP.

The next step was to fill key positions in the new team (senior consultants, team leads, and managers) with employees who were able to *consciously* apply both design and business logics. Recognizing this dual ability when building the new team was critical to ensuring that the team was not rejected, resisted, or viewed as a disruptive factor by the rest of the organization, sitting firmly on the business logic bench. Being able to adapt one's thinking and behavior to a design environment and a business environment is crucial in determining how designers are accepted in the rest of the company, and also ensures that the two worlds are able to relate to one other.

4.1 Key Capabilities: The Best Way to Organize and Manage Designers

In addition to the traditional command-and-control management style, antithetic leadership must manage designers. Leadership styles that are successful with designers have certain characteristics, which can be quite different from conventional management methods in a business context: they encourage employees to think for themselves as well as enabling them to deal with challenges in their daily work by using guidelines and principles rather than following methods or rules to the letter. This includes granting authorizations that minimize the need for employees to seek reassurance from management, and encouraging them to take responsibility for their own actions (the 'Encourage, Enable, Empower' concept).

The deployment of antithetic leadership at SAP BTS generated a number of best practices and findings. These items are discussed in this chapter according to their general validity and versatility across all organizations that are faced with the delineated conflict of business and Design Thinking.

4.1.1 Management Must Be Able to Relate to Each Individual Employee

Each designer wants to be seen as a person with her or his unique personality. There is a strong link between the job they do and the person they are. Design is a vibrant environment where explicit appreciation of worth means more than the evaluation of role-based, measurable performance. In many cases, leading designers is more elaborate than managing business teams. A manager of designers is advised to spend a considerable amount of time on the individual interaction with each team member—more so than with ‘business people’.

4.1.2 Forget About Conventional, Quantifiable Measures of Performance

Individual incentives jeopardize the innovative effect that can only be achieved by working together. In other words: do not optimize subsystems to the detriment of the system as a whole. Experience has shown that innovation is at its most successful when people share and connect their thoughts and ideas and develop them together. This includes identifying and discarding unstable constructs and substeps (‘fail early, fail cheaply’).

4.1.3 Designers Perform Better in Small Teams

The previous two points require relatively small teams, and a low manager-to-employee ratio. This is significant if managers are to relate to individual employees on a more personal level. To do this, the manager requires not only time and focus. The company or organization that is wanting to make innovation a key capability of its ecosystem, is advised to create an environment that makes small teams possible. That requires a waiver of all budget, control or career guidelines that discriminate against small teams, such as minimum numbers for span-of-control, and KPIs that neglect the higher personal costs or promotions depending on the proven management of large teams.

In a design team, as in a conventional team, it is not necessary to have the best or most senior expert as the lead. It is actually preferable to have a mentor figure who possesses excellent coaching and conflict management skills. Good (and patient) communication with the business organization is critical.

4.1.4 Embrace the Differences that Make a Difference

Diversification is another characteristic of successful design teams. Gather a team with as many intelligence types and personalities as possible, for example, logical-mathematical, musical, artistic, linguistic, bodily, spatial, and emotional (cf. ‘Team Roles at Work’ by Belbin 2010). To recruit and retain a broad palette of personalities in your team, your methods may need to be somewhat unconventional. For example, consider recruiting high-functioning but less socially adept individuals (‘experimental hires’) to make up as much as 5–15 % of your team. To rein in the centrifugal forces inherent to such a team, you need a strong personality at the helm, someone who can bring these different types together.

4.1.5 Irritation Comes Before Innovation

A design team often accepts behavior that borders on the antisocial, tolerating impudence, for instance, or emotional irritation. Experience has shown that this aspect of team culture is often more of an issue for the surrounding (business) organization than for the team members themselves. Those behaving in this way are viewed by the organization as, at best, disruptive, possibly even dysfunctional, and are reprimanded accordingly. Design and business areas must strive for a successful coexistence despite their contradictory and mutually exclusive organizational (sub) cultures. Managers must be adept at handling conflict and must have excellent interpersonal skills. They must follow the 'protect, defend, charm' principle, that is, they must be able to take irritations that are perceived as a risk or threat and frame them positively in the context of 'doing things differently'.

4.1.6 Tool or Toy: It's the Designer's Call

Management gives the team a scope for finding solutions by setting thematic boundaries (the 'define the scope' principle). This scope is based on the team mission, namely the problem area faced by the customer. To find a solution, the team needs a portfolio of appropriate methods and tools. Management not only has to grant the design team autonomy in selecting and using these tools, but the designers must be able to employ external tools on an ad hoc basis, and even develop their own tools if those available are not sufficient. These new methods and tools, if successful, are added to the portfolio and shared with the other team members. If a new tool or method proves unsuitable, the portfolio stays as it is, and any lessons learned are shared with the team.

This 'fumble and stumble' principle must be supported by management. In customer projects, this principle must be included in contractual agreements and requires explicit approval from the customer. In addition, management must defend their designers and protect them from any possible sanctions from the business logic side.

4.1.7 Celebrate Failure, but Don't Get Used to It

Management must accept from the outset the possibility that some methods or attempts will fail while finding a solution. The failure of individual tasks must be tolerated, but not encouraged. The 'fumble and stumble' approach allows ideas to be qualified and assessed for economic viability, executability, and appeal. Resources are limited, and you must quickly identify the ideas that justify investment. The quickest way to prove the hypotheses of an idea is by testing. It is okay to fail in tests—that's what they are there for—but the overall goal must be to improve the innovation portfolio. There is no universal mathematical equation to quantify the number of failures are that are desirable or tolerable in a test; it depends on the specific problem and the factors in the immediate environment that influence it.

4.1.8 Know the Rules and When to Break Them

Management needs to have a very good understanding of the social structure of written and unwritten laws that apply across the entire company. You may want to give your designers free rein to express their creativity, but if you disregard these rules you risk triggering an attack response from the organization's immune system, which could severely damage your design team. For this reason, management must understand which rules can be broken or ignored, which should be obeyed (officially at least), and those which must be followed to the letter.

4.1.9 Reward Differently

Consultants and managers with a design brief have to try to find a balance between design logic and business logic in goal setting. It may not always be possible to apply design logic, never mind antithetic leadership, as the team is still subject to the established controlling and HR processes of the organization.[5] A compromise is to dilute the incentive for employees to maximize their individual variable salary component by introducing a non-monetary element. Full or partial project autonomy schemes have proven to be successful (where employees get to devote an agreed percentage of their work time to a project close to their hearts), as have external training courses, which need only be loosely related to the employee's work tasks (for example, coaching, self-awareness, or language courses).

4.1.10 New Paths in Further Education and Professional Development

Further education and professional development for designers should focus on imparting and developing personal skills, such as networked thinking or positive irritation and provocation, rather than a methodical teaching of technical standards. Therefore, conventional classroom teaching methods (case studies, for example) or e-learnings are *less* suitable for designers. BTS initiates its novices in innovation consulting into Design Thinking by starting them on intensive training projects at one of SAP's more untypical customers. This training model is as simple as it is effective.

Participants spend 3 days at a small, relatively simple company, which in return gets the consulting services provided by the trainees for free. The company presents the training group with a business challenge, to be solved using Design Thinking.

[5] See Kotter, 'Accelerate!' (article in Harvard Business Manager in 2012).

On the first day, management and company employees provide the participants with information and supply facts and figures about the problem. The training takes place at the customer site and in a project room booked for this purpose at a nearby location. Generally, the customer has already tried conventional, rational–logical methods by this stage, but without success.

One such training project was at an indoor climbing center in a large German city, where a concept was developed to increase the number of new customers signing up for chargeable courses after having enjoyed free trial sessions. Another training group, at a family-run brewery in rural Lower Franconia, also in Germany, provided 70 proposals for converting a centuries-old production site into a revised business model with significantly increased sales.

The objective of all of the training, as well as the conventional transfer of knowledge, is to provide the trainees with positive experiences by letting them learn how to use the tools in real-life situations. Information technology aspects are deliberately kept out of the training, to draw the SAP participants out of their comfort zone.

5 Applying Antithetic Leadership in the Field: Successful Customer Projects

Successful customer projects at SAP BIT show that this approach gets results. After two and a half years of developing the concept, the team is now active in projects that extend the logic of SAP transformation projects horizontally, by getting itself involved before the transformation stage (usually the implementation of technological solutions). Here are some examples:

- Upgrading the role of Chief Information Officer (CIO) to Chief Innovation and Information Officer (CIIO) to reflect the organizational changes of switching to cloud technology.
- Discovering new potential for business models that are no longer economically viable due to recent innovations in information technology or sudden shifts in demand (for example, at energy suppliers, shipping companies, and public sector companies).
- Developing organizational structures that enable a conscious and dynamic innovation culture at SAP customer sites with success measured by the quality and quantity of the innovations this culture promotes.

One of the main benefits that BIT brings to SAP is the extension of the pipeline for transformation projects. By extending the capability scope horizontally, it is now possible for SAP to get involved in the definition of transformation projects at an early stage and take operational elements of the solution into account when verifying ideas in innovation management (see Fig. 2).

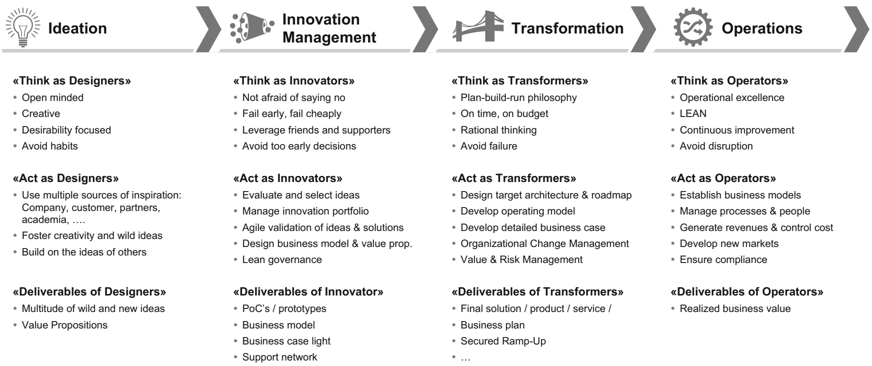

Fig. 2 Roles, tasks, and responsibilities in each stage

6 Conclusion and Key Learnings

Antithetic leadership is becoming an indispensable management approach in companies, and not only in the particular macroeconomic situations we have described. We are convinced that antithetic leadership will become the method of choice anywhere management approaches clash within an organization. It can also be applied to inclusion (the leadership and management of people both with and without disabilities), for example, or to the field of academic research, which also needs to meet economic requirements ('scientifically motivated free thinkers versus the market'). The statements we make about antithetic leadership serve as an example and as a guideline for management behavior.

Antithetic leadership does not apply only to business and design; it can be used anywhere you have fundamentally different behavioral and management mind-sets: a manager who leads antithetically chooses the relevant elements of the respective management system, depending on the situation. This redefines best practice in management behavior. Instead of searching for precedents to use as a template to solve a given challenge, it is the ability to grasp and intuitively combine and expand management elements from both worlds that ensures success. Antithetic leadership represents a quantum change in conventional management theory. We consider antithetic leadership to be no less than the creative destruction of established management concepts. And with so much emphasis placed on 'lifelong learning', further education and professional development should also adopt an antithetic approach to knowledge transfer. In problem-solving, looking at the context of a task or problem will become increasingly important, which will further diminish the relevance of simple, causal models. Antithetic leadership agrees to a certain degree with Ashby's Law of Requisite Variety from the field of cybernetics, which states that if a system is to be stable, the variety of a control mechanism (in our case, management) must be greater than or equal to the number of states in the system being controlled. The roles of trainers and trainees will merge and, as shown in our example of intensive training projects at SAP BTS, knowledge will be created in a collaborative and transdisciplinary way.

Key Learnings

- Today, no organization that views the ability to innovate constantly as inescapable can build a leadership style built solely on business-thinking. The impact of this enlargement will transform company cultures. Vision and mission will become multifaceted.
- Antithetic leadership will change the understanding of ‘diversity’. This necessary feature of an agile organization isn’t about gender, religion, or race, but rather about different ways to think, to behold, to contemplate and solve issues. To foster diversity, it is important to manage competencies as well as knowledge, which in turn leads to a newly defined HR policies.
- Antithetic leadership requires a different interplay between management and employees. ‘Trust is good, control is better’ recedes into the background, making room for a cooperation that requires the readiness to accept unexpected outcomes (by the leaders) and less guidance and, as consequence, security and an overdone dosage of predictability (by the employees).

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Dr. Michael von Kutzschenbach has been responsible since 2011 for managing international transdisciplinary research and consulting projects on innovation, business transformation management, and sustainability. With over 15 years’ experience as an academic and consultant, he provides clients with postgraduate education, and does research and consulting work in the interaction of hard and soft systems thinking, especially in the areas of organizational learning and management for ‘less unsustainability’.

Peter Mittemeyer is heading the Business Innovation & Transformation Team within SAP Business Transformation Services working with the SAP customer base to create business model innovations in the digital economy. In addition as Global Head of Service Innovation for SAP Peter is leading a dedicated team of innovators focusing on creating new service business for SAP in the digital economy. Peter started his professional career 21 years ago as the product

manager for the market introduction of "Bionade", one of the most innovative products in the beverage industry. Later Peter worked as management consultant in the utilities, music, logistics and manufacturing industry and then took over responsibility as "Head of Logistics and Manufacturing Europe" at a global automotive supplier in Germany.

Werner Wagner is a Director at SAP, heading the Industry Consulting Teams within Business Transformation Services. The focus is on Telecommunications, Public Services, Banking, Automotive, Oil & Gas, Retail, Chemicals and several other industries. The key consulting competencies of BTS in this area are spanning Enterprise Architecture Design, Business Process Management and Value Management. Prior to joining SAP, Werner Wagner was senior manager at different service and support partners of SAP, such as TDS, Price Waterhouse and T-Systems.

Digital Culture: Why Strategy and Culture Should Eat Breakfast Together

Guido Wokurka, Yvonne Banschbach, Dominic Houlder, and Richard Jolly

Abstract Digital transformation can create new business models, improve business processes, and change how a company works with real-time information. High expectations are set for the resulting disruptive and ongoing innovations, yet promising business transformations, with expected high business benefits for customers and the organizations, often fail because they collide with the company culture. In this chapter two best-practice examples illustrate how to avoid such failure by driving the changes in culture that can lead companies to digital success (The title of this chapter is inspired by Peter Drucker's alleged statement 'Culture eats strategy for breakfast').

1 Overview

The digital transformation is promising for creating new business models, improving business processes, and changing how we work with real-time information. High expectations are set on disruptive and ongoing innovations that will facilitate the evolution of new and improved business models. As a consequence, the digital transformation shows has the potential to challenge existing company- and industry-wide structures and management practices that have been in place for decades. From this perspective, the digital transformation is not only promising but also challenging.

While great emphasis has been placed on the technological and economic changes ascribed to digital transformation, one of the driving factors of

G. Wokurka (✉)
SAP Business Transformation Services (BTS), SAP Deutschland SE & Co.KG, Walldorf, Germany
e-mail: guido.wokurka@sap.com

Y. Banschbach
SAP HR Organization Development & Leadership, SAP SE, Walldorf, Germany
e-mail: yvonne.banschbach@sap.com

D. Houlder • R. Jolly
London Business School, London, UK
e-mail: dhoulder@london.edu; rjolly@london.edu

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transformations that receives scant attention is organizational culture. A large body of academic research (more than 4600 articles since 1980) has been devoted to the topic of organizational culture, in large part because the environments we create in organizations shape behaviors (Smirchich 1983). We do not operate as individuals in a vacuum; our actions and performance (Barney 1986) are significantly influenced by the context in which we find ourselves.

Organizational culture is usually defined as "the set of shared, taken-for-granted, implicit assumptions that a group holds and that determines how it perceives, thinks about and reacts to its various environments" (Schein 1996, p. 336). Such implicit assumptions always exist, but making them explicit and discussing them is a critical element in ensuring that the environment we create supports the organization's goals.

A strong culture is often linked to strong organizational performance (Deal and Kennedy 1982), particularly when there is congruence between employees' personal beliefs and the group's shared beliefs (Cameron and Freeman 1985). However, such congruence, which is usually a benefit, becomes challenging when the organization is undergoing a change process, particularly one that affects the capabilities that are necessary for success. When a significant technological change forces an organization to adapt its way of working, ensuring that the cultural dimensions receive their due attention is an important element in managing an effective transition (Harris and Mossholder 1996).

Cultures can come together in any of three patterns (Mottola et al. 1997). One culture can absorb the other; the two cultures can blend, broadly maintaining the features of both; they can combine in such a way that the new culture resembles neither of the two previous cultures. This third pattern of evolving both elements into a new hybrid has been found to be the most effective in creating value for the organization (Mottola et al. 1997).

While the need to adapt to a digital environment may be inevitable, there is no certainty that such a shift will create value for the organization (Weber and Pliskin 1996). Therefore, explorations of how to manage such a process successfully in an organizational setting can help to clarify the practical steps necessary for attending to the cultural context as a critical element in adapting to technological change.

Culture either accentuates or extenuates the challenges and potentials of digital transformation. Even the best-designed digital strategy may fail if the company's culture does not embrace the changes, such as when employees do not go along with the transition toward new, digitized customer channels. Bughin et al. (2015) revealed a strong positive link between digital performance and a risk-taking culture, that the primary asset in helping organizations attract and retain digital talent is culture, and that a lack of leadership and talent are the greatest challenges companies face in meeting their digital priorities.

Only when a company pays attention to how it integrates digital technologies, systems, processes, and structures into its corporate culture and ensures that its culture is fully embraced and lived by its employees will it be able to exploit its digital capabilities fully and make its digital transformation sustainable. Using two case studies, we show the challenges that SAP faced while becoming digital and how the company honored the cultural dimensions of this transformation. In so doing, we demonstrate what makes a culture digital and how to incorporate digital features into an organization. We also address the lessons learned from SAP's culturally integrative work during its digital transformation.

2 Culture as the Ultimate Game-Changer for Going Digital

2.1 Digital Culture

A company must invest time and resources of all kinds to create and implement a new, digital culture. Even only altering the existing culture requires time and resources. The earlier such cultural change is made, the more likely the new business models and new opportunities can be lived and executed upon and the company will gain the ability to meet customer demands and competitors' threats swiftly and appropriately.

Customers choose their own information and purchasing journey in multiple channels at their convenience, establishing the need for a true digital strategy (Catlin et al. 2015). In order to live up to customer expectations of a digital experience that is frictionless, where commerce is seamless, and where technology is invisible, SAP had to go through transitional phases in adapting culturally to the digital world internally as well as in ways recognizable to the customer. Being able to drive digital business innovation for SAP's customers in a simple, yet sophisticated, way meant that SAP itself had to be simple and innovative regarding its customers. In addition to many other interventions, this requirement led SAP to internal transformations and strategic external acquisitions.

One major internal transformation that SAP had to face was the SAP® ONE Service transformation in 2014. The goal of this internal transformation was to put the customer at the center of everything and to allow for a digital customer experience that is simple, seamless, and personalized and that works across any channel at any time using any device. SAP Services and SAP Support were two business areas that had not only to go along with these changes but also to work closely together to implement them. This chapter outlines how the leadership of the *Business Transformation Services* team and the *Enterprise Support and Premium Engagement* team in EMEA North (BTS-ESPE) made the journey to develop an organizational culture that supported these changes toward a digital solution holistically and in a sustainable way. We also present the case of a strategic external acquisition that SAP made in 2013, the acquisition of hybris®. hybris is not only the world-leader in omni-channel solutions for customer retention, it is the world's fastest-growing e-commerce software company. Offering a complete omni-channel commerce platform that incorporates Web, mobile, call center, and store solutions, hybris helps businesses to sell more goods, services, and digital content through every touch point, channel and device with unified commerce processes for all channels. hybris was an ideal partner in SAP's process of digital transformation, as it positioned SAP to deliver the next-generation e-commerce platform just as enterprises around the world were seeking to optimize their customers' experience across an ever-growing number of delivery channels, devices, and touch points. From an organizational perspective, the strategic decision was made to integrate hybris into SAP and to structure a new line of business called 'Customer Engagement and Commerce' (CEC).

Corporations and their strategies stand or fall on their ability to integrate activities, resources, and their cultures. To succeed sustainably, any corporation needs a *corporate advantage* that demonstrates that the whole exceeds the sum of its parts (Porter 1989). These synergies (Campbell et al. 1995), which involve integrating previously separate activities and resources, may take a variety of forms, among which are vertical and horizontal synergies. *Vertical synergies* can involve managerial interventions from a corporation's headquarters to influence the component businesses and functions to take actions that would not otherwise have occurred. Vertical synergies can also involve the provision of central capabilities, such as those related to R&D, branding, finance, and talent management. *Horizontal synergies* are links between businesses and functions in the corporate portfolio. These links might involve knowledge-sharing to extend best practices or stimulate learning and innovation, bundling to create new solutions, shared purchasing or sales to realize market power, and cost savings through scale and complementarity. All of these synergies are potential sources of corporate advantage.

As attractive as these synergies sound, they are notoriously difficult to realize. Many studies have shown, for example, that M&A, on average, destroys value for the shareholders of the acquiring business, so the acquirer, who has the integration task, typically encounters integration costs that exceed the value of the promised synergies. What's more, London Business School's recent research (Sull et al. 2015) into strategy execution showed that, while managers can typically rely on their bosses and subordinates to do what they say they will do, only 62 % of the managers surveyed felt that they could rely on colleagues in other units most of time (Sull et al. 2015). Beating the typically disappointing results of M&A or successfully integrating organically developed activities requires understanding the pitfalls and costs of integration and how to avoid them (Capron and Pistre 2002).

Integration means disruption. It changes how activities are performed, alters the human behavior that drives them, and so impacts the underlying culture. What can be done to avoid the costs of disrupting cultures? One option is to minimize the degree of integration. At Berkshire Hathaway, for example, Warren Buffett and Charles Munger avoided attempts to create horizontal synergies between businesses and limited synergy to vertical interventions around the appointment of top management in acquired businesses. Martin Sorrell, CEO of the media giant WPP, exercises tight financial control across the group but conserves the distinct brands of his portfolio companies and pursues horizontal integration only around certain business opportunities. However, a minimalist approach to integration, while reducing cost, may leave value on the table. Where there is potential value, what can be done to ease the ways to the collaboration that yields synergies?

The costs and value of integration are also functions of the relative maturity of the activities that are being integrated. Managers can think of business opportunities as evolving over time, from start-up initiatives to coming to scale, maturity, and managed decline. The leadership attributes, success measures, risks, and required skills differ in each phase, posing an integration challenge but also an opportunity. Integrating a start-up initiative into a mature unit is likely to result in suffocation—a looser relationship is more appropriate—but as the start-up initiative becomes ready to begin scaling, integration with the resources and capabilities of a more mature unit can accelerate the process and reduce risk.

2.2 The SAP® Journey Toward Digital Integration with CEC and BTS-ESPE

When we used structured interviews (varying hierarchy level, age, gender, and role) to analyze the hybris integration and that of the collaboration and working model of BTS-ESPE and the results from the latest employee survey, we found two slightly different situations. What we found (from a cultural perspective) for the hybris integration with SAP was the challenging situation of bringing two companies of *different cultural backgrounds* into a position where they could both *embrace a new digital culture*, recognize and appreciate their different backgrounds, and find new ways of *working together effectively and efficiently* with the aim of *establishing a new, agile business organization set for digital integration*. SAP had to initiate certain measures but also to implement an entire change architecture that would address a variety of organizational dimensions to carry the change into the newly created line of business, CEC.

For the BTS-ESPE team collaboration in the context of the ONE Service transformation, we found that a much smaller scope than we used for hybris would suffice, such as one in which the team works out how to relate on a behavioral level and what digital features require their attention if they are to meet their strategic goals related to digital integration.

When we started the process of bringing together two cultures, hybris and SAP, to create a new culture that is set up for digital integration, we did so with a multichannel approach that focused on various *culture levers* (Harshak et al. 2013). Culture levers define a company's path toward a digital organization, as they include all aspects and cultural dimensions of the company. We distinguish between formal and informal culture levers. Formal culture levers, as we understand them in our approach, refer to *leadership and employee processes and role definitions*. They set the framework for the new, digital organization. As a consequence, global information and onboarding sessions were held for managers and employees, and *major HR processes* like performance management, talent management, and the reward system were outlined in terms of how the new digital business model would work with regard to CEC and how the new business aims and objectives could be reached. Moreover, *technical training* and *clearly defined roles set up for digital integration* contributed to ensuring that managers and employees

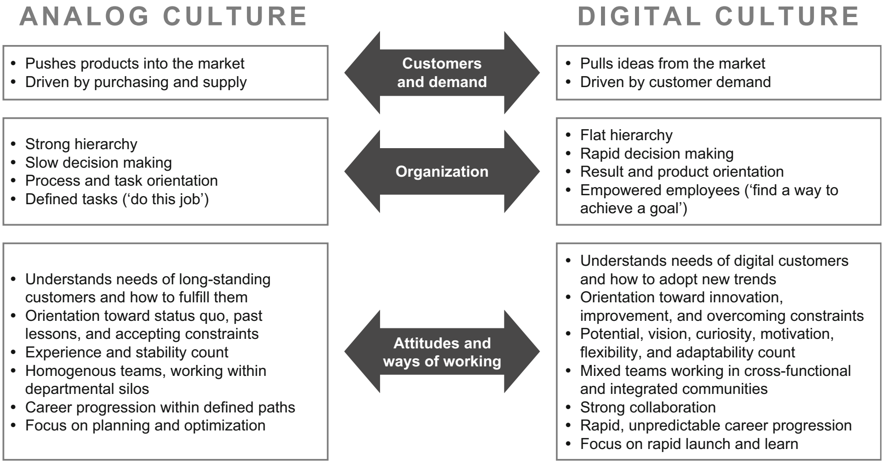

Fig. 1 Features of analog culture versus digital culture (*Source*: Harshak et al. 2013)

could find their way into the new organization with clarity about their roles and any role expectations they might have. Only if employees and managers understand and are trained in what needs to change about their roles can they adapt to the specifics of digital business. With regard to CEC, this means, for example, that a salesperson does not necessarily always meet a customer in person but may also use multiple channels like online platforms and apps to stay in contact. Time and investment are needed before employees can adapt to these new behaviors and a new mindset can be created.

Just as clear and comprehensive offerings of information and onboarding activities for the formal culture levers are needed, an intuitive and open approach to the *informal culture levers* are as well. Information culture levels refer to *behaviors, values, and beliefs* that will form a new culture set-up for digital business. These informal culture levers distinguish ‘how we do things around here’ and are the *most effective influencers of the direction that a new digital culture should take*. As an illustration of what a company must address when leaving an analog culture for a digital one, Fig. 1 from Strategy& summarizes three key dimension on which a company should focus (customer and demand, organization, and attitudes and ways of working) and sketches out the types of behavior in which the employees must engage in order to make a digital culture stick (Harshak et al. 2013).

In order to work effectively on the informal culture levers, SAP worked directly with the managers of the new line of business in *onsite workshops* in the main locations of the new line of business. SAP created a workshop design that allowed for sufficient time and space to consider carefully the emotions, values, and behaviors that would constitute the digital culture of the new organization.

One of the main goals for the BTS-ESPE team was also to develop a team that was ready for digital integration, one that knew how to interact and perform in order to serve their customers well. Therefore, SAP applied a similar workshop approach to this project.

2.3 What We Did: X-Change on Change and Culture Workshops

To meet these needs, the workshops involved managers from both sides of the organization, hybris and SAP on the one side and BTS and ESPE on the other. Managers from both units working together had a high priority as only then could true culture exchange take place. Managers from both sides had to work on what had to be done to develop a culture that combined the best of the two units and to define what was required to sets up the organization for digital success.

In order to identify these needs, the first day of the workshop was dedicated to the implications that change can have for individuals and groups and how to deal with one's own and one's team's emotional aspects of the change. We found that this step was one of the most important during the process. As in every major transition or transformation, managers have to act as role models and not only talk about the changes but embody them. Only if employees see and feel that their managers take the changes seriously and show it consistently in their behavior by 'living' the change and acting in a new way will employees believe in what has been professed as a new digital strategy and 'walk the talk' in their own everyday business lives and interactions.

The basis of the exercise is the *change curve*, derived from the Swiss psychiatrist Kübler-Ross (2005). During the exercises, managers can talk about the stage of the transformation in which they are, where they think their team is, and most importantly, how to respond to their employees' needs when their employees are in a state of, for example, denial, anger, or grief.

During the development some employees always want to protect their old habits, beliefs, values, and behaviors, which have served them well, sometimes for decades. It is normal for an employee to want to hold on to his or her traditional approach to customer contact by visiting them on the shop floor. However, as the approach to digital e-Commerce in the CEC project involves online chatting in real time, virtual and contextual interactions, and reacting to the customers' latest blog, these new ways of interaction and collaboration can cause many to have feelings of uncertainty, loss, or resistance. In order to support their teams, managers must first find out for themselves where they are on the 'change curve'. Their own management may want them to be participative leaders who can empower their teams to collaborate despite being in an organizational structure that does not really support such a leadership style. In all likelihood, there will be demands for quicker decision-making, though without distinct guidelines on how to do it, as strict processes and structures hinder them. The more managers know about how they feel about the change, the better will they be at understanding where their teams and

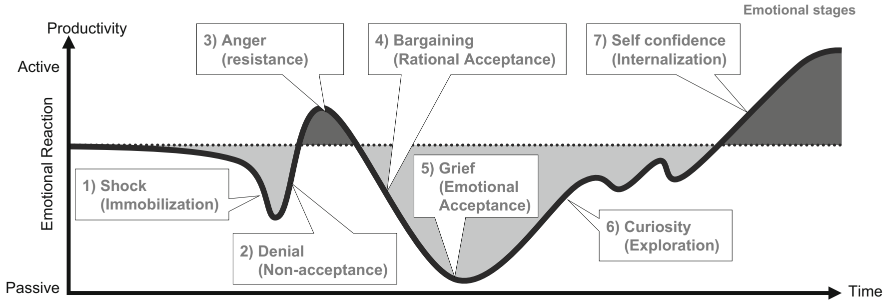

Fig. 2 Change curve (adapted from Kübler-Ross 2005)

individual employees are and the better their abilities to support them when emotions like grief or resistant behaviors show up. Figure 2 shows the change curve with its various stages.

The topic of the second day of the workshop was joint digital culture. The challenge was to bring together managers and employees from different organizational culture backgrounds, different working styles, and different mindsets in order to learn to work effectively in a new joint business that thrives on digital success.

To this end, Schein's (2004) Iceberg Model was introduced in the workshops since not all of what forms a digital culture takes place on a conscious level. When a company wants to change an existing culture and its habits and behaviors, it must also address the more unconscious levels in the form of *values* and *fundamental assumptions* (Fig. 3).

Discussing the three stages is important, as it sets the foundations for how well the digital culture will stick, as only part of it is visible. For example, if I expect an employee to use a multichannel sales approach in a digital environment from now on, while his or her fundamental assumption is that laziness is the only real reason for not visiting a customer in person, he or she will never buy into the concept of meeting the customer via telepresence and online interactions.

The final major building block, aside from the change curve and the iceberg model for organizational culture, is making all the experiences real, concrete, and crisp. SAP did this in form of a world café-style exercise, where managers worked in groups on questions related to the emotional lessons learned from the change curve, as well as on the lessons learned on behavior, norms, and assumptions. Most importantly, the managers focused on identifying what is really needed in everyday business life in order to be successful in a digital world.

The managers focused on four questions:

(a) What *leadership principles and behaviors* have to be established in order to be successful in the digital world?
(b) Which of the company's existing *values and work principles* are essential to ensure a successful landing in the digital future, and what needs to be added?
(c) If a client were to come into our offices, how would he or she see the *digital spirit* manifested, and what would the *future digital workspace* look like?

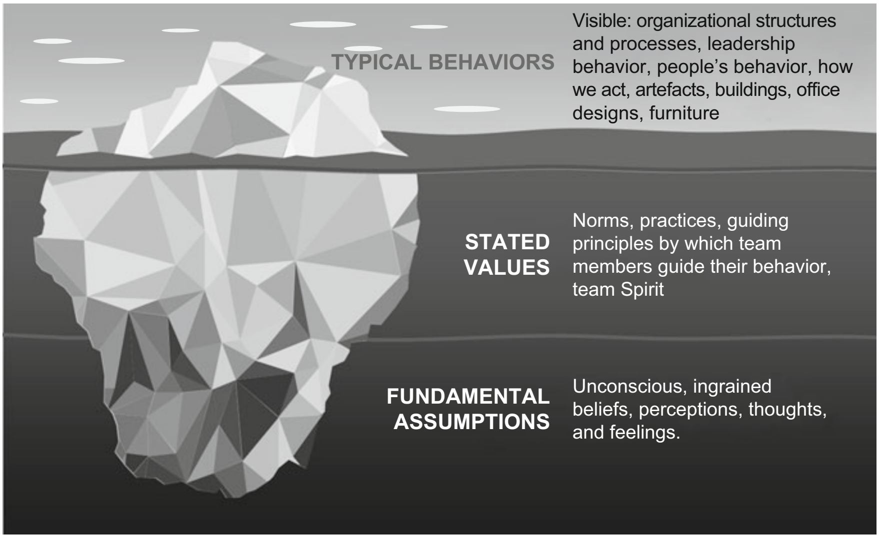

Fig. 3 Iceberg model on organization culture (based on Schein 2004)

(d) What skills and competences do our employees need to develop in order to work effectively in the digital world?

This exercise proved to be helpful for the managers, as it made clear how concretely their own and their employees' behavior needed to change. In so doing, they discussed how they as mangers could promote risk-taking and have it valued in their teams, how they could be proactive and ensure that trends find their way into their organizations quickly, which work principles they had to introduce in order to bring innovation into their teams, and what mindset they and their teams needed in order to collaborate quickly, overcome silos, and work cross-functionally.

In this exercise managers not only work on the features of a digital culture but also work out *how* they implement the required new behaviors and mindset in their organizations.

3 Conclusion and Key Learnings

'Culture eats strategy for breakfast' is an experience many organizations learn the hard way. Promising business transformations with significant expected business benefits for customers and the organization have failed because they collided with the company culture. The same holds true for a company's development toward a digital world, especially when it faces transformations that focus on the technical part of digitization. Often the cultural and human aspects of change fall short or, at best, take second place to the technological changes. However, companies that want to achieve success during phases of rapid change, particularly digital business transformation, must focus on four cultural aspects in particular:

1. Managers and their teams must work out what the new digital strategy means for them on a day-to-day basis, as well as on a long-term basis. What will set up their organization for digital success must be defined. If insufficient time and resources are invested in this process, the company will be stuck in high-level discussions about the company's digital potential, but will not detail out what the digital strategy is and how it comes into practice.
2. Culture is an essential element in driving a successful business transformation. Depending on the situation, one common, integrated culture or the coexistence of two cultures under a common leadership could be the best support for a digital strategy. The cultural-integration option can create significant benefits in the effects of scale, experience, and leverage. The downsides of cultural integration are its complexity, its disruptive nature, and impairment of human resources. The resource perspective and the life cycle perspective can give valuable insight into when and when not to integrate cultures.
3. People's emotions and feelings must be taken seriously on the road to a digital business. As they work and collaborate in a digital environment, they have to let go of old habits and beliefs—a tall order. In addition, not everyone finds it easy to use social media to communicate with and relate to the customer; many prefer to meet customers on a 'shop floor' level.
4. Managers must work with their employees on the *concrete behaviors* that prepare the company ready for digital success. Managers must learn how to teach what it means to act and think in a different way. As SAP did it in its X-Change on Culture and Change Workshops, focusing on the underlying values and assumptions can be valuable, as it often reveals the true reasons why people might be resistant to change.

Key Learnings

- Culture and strategy should be aligned—The digital culture creates special requirements for customer orientation, the organizational design, and the approach to collaboration. Business innovation plays an even bigger role. All of this must be reflected in the digital strategy to ensure a strong competitive advantage.
- Leverage the experience from other digital business transformations—The change curve and the iceberg model are helpful in supporting organizations and individuals during the organizational change process. Evaluate the costs and value of integration.
- Bring people together and support them in their development—Take managers' and employees' emotions and feelings seriously and focus on the concrete behaviours that prepare your company for success in a digital world.

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Guido Wokurka is a senior manager and head of Business Transformation Services in Northern and Western Europe. He is supporting many customers in their digital and business transformation journeys e.g., as executive sponsor. He also works SAP internally as a Business Coach and as Mediator in conflict resolutions for SAP's most senior executives.

Yvonne Banschbach is an Organization Development and Leadership Senior Consultant at SAP who has led small to large transformations at SAP with a special focus on culture, innovation, post-merger integration and Design Thinking. Since starting at SAP in 2007, she has held several roles in HR. Banschbach studied sociology and music therapy and is a certified Organization Development and Design Thinking Coach.

Dominic Houlder is Adjunct Professor of Strategy and Entrepreneurship at the London Business School and an expert on business-to-business and professional services firms. He helps the leaders of major firms to connect with their clients, their colleagues, and themselves in new and compelling ways. His current research focuses on the transformation of professional service firms. He brings a mix of theory, practical experience, and spiritual insight to his work.

Richard Jolly is Adjunct Professor of Organizational Behavior at the London Business School. His teaching portfolio includes courses on leadership and core Organizational Behavior topics and focuses on teaching about managing change, power, and politics. He also instructs a large number of Executive Education programs for the school in the UK and across Europe, the Middle East, and Asia.

Designing Business Models for the Digital Economy

Michael Blaschke, Marco Cigaina, Uwe V. Riss, and Itzhak Shoshan

Abstract Digital technologies are increasingly shifting the boundaries between everybody's lives and information technology urging companies worldwide to address this vital topic. This requires a systematic approach to business model innovations, treating technical and business aspects in an integrated way. Currently one of the difficulties of such an approach is the lack of a common conceptualization to be used by both business and technology experts. The current chapter attempts to remedy this based on the interconnection of nine components of business model representation and five 'Digital Key Elements'. The elements of the resulting matrix are called 'Digital Value Drivers'; these describe the effect each digital key element has upon the various business model components. This matrix is transformed into a graphical representation and used in SAP Business Model Development and Implementation (BMDI) method to be then applied in Design Thinking workshops. BMDI is an iterative multi-step method aimed at designing innovative business models. Examples illustrate how the conceptualization is applied and how it enables to proceed from a digital business model design to an implementation in terms of 'Service Design'; this includes persona development, customer journey map and service blueprint. Through this procedure we have obtained an integrated methodology for the systematic development of digital business models.

M. Blaschke
University of St. Gallen, St. Gallen, Switzerland

SAP (Schweiz) AG, Biel, Switzerland
e-mail: michael.blaschke@sap.com

M. Cigaina
SAP Italia S.p.a., Vimercate, Italy
e-mail: marco.cigaina@sap.com

U.V. Riss (✉)
SAP (Schweiz) AG, St. Gallen, Switzerland
e-mail: uwe.riss@sap.com

I. Shoshan
SAP Portals Israel Ltd., Ra'anana, Israel
e-mail: i.shoshan@sap.com

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1 Overview

Digital transformation is a vital topic for companies worldwide. It usually involves discussions around advanced analytics, social networks, mobile telecommunication, or similar phenomena. Often the topic is associated with successful companies such as Google, Facebook, Amazon, or Uber. Digital transformation blurs the line between our lives and technology. The way technology has become part of our day-to-day lives has readjusted the role of Information Technology (IT). IT has gone from being a mere enabler of value generation that is somewhat agnostic towards the customer to becoming a universal value facilitator that involves the customer in a value (co-)creation process. In this way IT has become closely connected to the business world. Companies which intend to develop their digital capabilities, i.e., their ability to generate business value from digital technologies, have to engage in a simultaneous (re-)design of both technology and business artifacts in order to be successful (Westerman et al. 2014).

In the course of this development business models undergo changes at the same pace as technology. Digital transformation affects business architecture in all areas (e.g., strategy, business model, organization, processes, solution portfolio, technology, competencies). This makes business model (re-)design vitally important, necessitating business leaders to take a systematic approach in this direction.

To address this challenge SAP has developed Business Model Development & Implementation (BMDI)—a methodology for adapting business models to future demands brought about by accelerated changes (Doll and Eisert 2014). BMDI is the fundamental methodology for SAP Business Model Based Management approach (Eisert and Doll 2015). Viewing digital transformation we see that BMDI methodology has to integrate characteristics of digital technology in order to meet the environment particular to digital transformation. To achieve this end we provide a new conceptualization as the basis of a shared language for describing, visualizing, assessing and changing digital business as well as for explaining causes and effects. Although it does not yet provide strictly defined semantics and syntax we nevertheless use the term *language* to indicate that it enables business and technology experts to efficiently communicate on *Digital Business Design*.

This language complements the existing dimension of business model elements (Osterwalder and Pigneur 2010) with a second dimension of 'Digital Key Elements' (Cigaina and Riss 2016). It enables us to discuss, analyze and design digital capabilities together with the corresponding business model features. We also use this language to adapt the BMDI methodology to transform it into a powerful instrument for conducting digital transformation.

In the following sections, we will present this approach and its use in more detail. Section 2 explains the foundation of BMDI methodology. Section 3 introduces the concept of digital-value drivers as digital-specific complement of the business model representation. Section 4 provides an example of how the new language influences the design of new services based on the described methodology. Finally, we point out the key insights.

2 BMDI: SAP® Business Model Innovation Methodology

We shall begin, before elaborating the details of Digital Business Modelling, with a short introduction of the underlying BMDI methodology. BMDI is a powerful but technology-independent business model innovation methodology based on Design Thinking (Brown 2008). The current approach assumes BMDI and adapts it to the particular needs of Digital Business.

2.1 Importance of Business Model Innovation

Technological innovation does not guarantee business success. Often products and services can be copied easily, whereas business model innovation can provide more sustainable market success (Kim and Mauborgne 1999). Consequently, "new product or service development efforts should be coupled with a business model defining 'go-to-market' and 'capturing value' strategies" (Teece 2010, p. 183). Moreover, business models can "reshape industries and drive spectacular growth" (Johnson et al. 2008, p. 52). The insight into these effects has caused business models to garner increasing attention in practice and research.

We consider two instruments as crucial for the enabling of successful business model innovation: an expressive business model representation and a suitable methodology. These constitute the key elements of SAP business model innovation instruments that we will describe in the next sections in more detail.

2.1.1 Business Model Representations

Every business model representation should capture the key aspects of the company's business and the 'Business Network' it operates in. These key aspects should address four questions:

- What value propositions are being offered?
- Who are the customers?
- How do operations have to work?
- Why is the business model financially interesting?

Business model representations can be adapted to the specifics of a company or a situation (e.g., start-up or new market conditions). Descriptions of business models are neither right nor wrong, but they can be appropriate or inappropriate when applied to a particular purpose.

Currently, Osterwalder's Business Model Canvas (Osterwalder and Pigneur 2010) is among the most popular business model representations. SAP understands it as an 'Enterprise View' (see Fig. 1) and has complemented it by a 'Network View' (see Fig. 2) to address more complicated business settings. In fact, these two

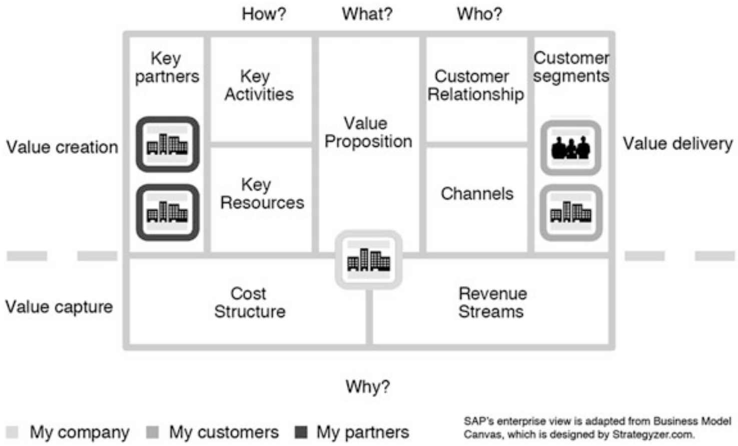

Fig. 1 SAP enterprise view representation

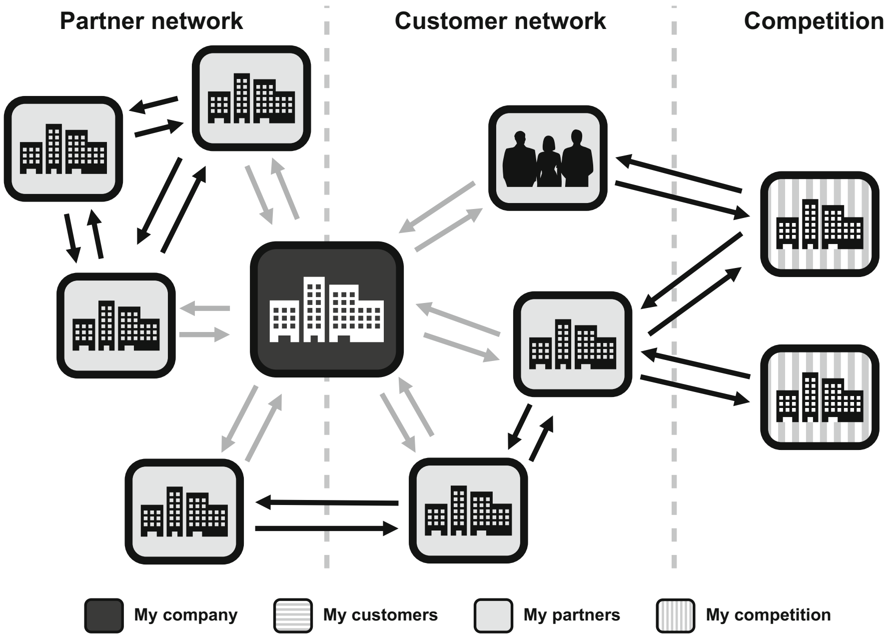

Fig. 2 SAP network view representation

business model representations complement each other, describing two levels of granularity:

- The Network View describes the value creation of a whole business network—your company, customers, partners, and global competition. It highlights the entirety of the business network and its interrelations.

- The Enterprise View describes the value creation of a single company participating in the business network, and shows how the network's value creation relates to and is implemented by the business model elements of this company.

The two representations have been used as the basis for a systematic procedure for business model design and innovation: the BMDI methodology.

BMDI is a multi-step procedure that starts with a representation of the current business model as its baseline in order to then proceed using four major steps:

- Analyze and improve.
- Challenge and change.
- Test and verify.
- Evaluate and decide.

These steps can be gone through in any sequence and be repeated as needed. A more detailed overview of BMDI is provided in (Doll and Eisert 2014).

3 Structured Approach to Digital Business Model (Re-) Design

Jorge Lopez (2014) explains the transition from e-business to digital business as the 'presence and integration of things, connected and intelligent, with people and business'. An interconnection of this kind requires a network that ties everything together and a cloud infrastructure providing all services necessary for coping with every demand of today's business agility. A final element in digital business involves leveraging the potential of transactional and analytical processing, such as that used by Google's search algorithms or SAP large-scale in-memory technology. We call these ingredients digital key elements. The impact of digital key elements on the business model is described by digital value drivers, which have been derived from an analysis of about 50 different digital business models. We will systemize them in the following section and explain how they can be incorporated in the business model design methodology. A complete list of digital value drivers is provided in the SAP whitepaper on digital business modelling (Cigaina and Riss 2016).

3.1 Digital Key Elements

Business and IT lack a common language managing to consistently discuss, analyze, and design opportunities from the digitalization of business. On the business side BMDI is an established approach providing a language to model the way organizations create, deliver and capture value, whereas on the side of technology we still need a similar minimalistic, yet semantically rich conceptualization so as to

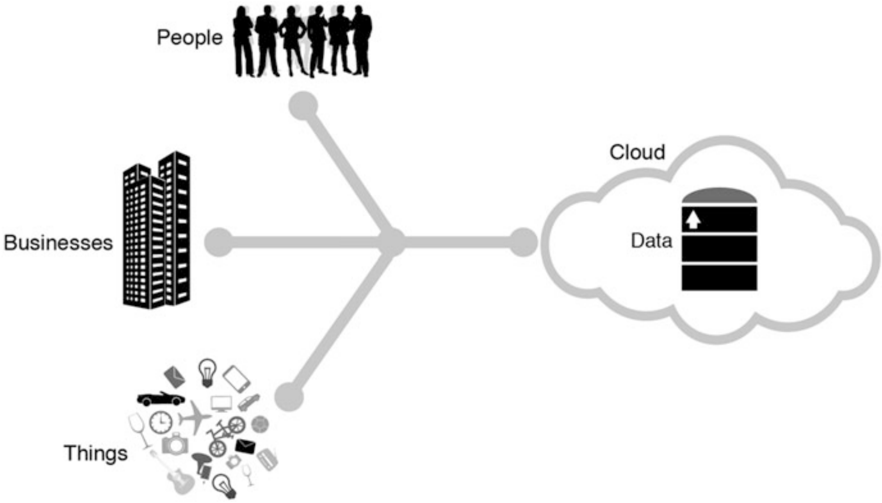

Fig. 3 Digital key elements

model digital capabilities. This conceptualization of the technology side is represented by five digital key elements. These are taken into account in order to identify value drivers in each business model component.

The conceptualization we suggest is a synthesis of different views that IT analysts,[1] vendors, and practitioners commonly use. We propose discussing, analyzing and designing digital capabilities through a minimalistic, object-oriented, functional representation based on five key components we call digital key elements (see Fig. 3):

- People.
- Businesses.
- Things.
- Data.
- Cloud.

These digital key elements take a business perspective on digital capabilities going beyond a mere technological one (Cigaina and Riss 2016):

- *People* in the digital age are creative, informed and knowledgeable. They are at once source and foundation of the digital economy. The term 'People' is used as an *abbreviation* for 'digitally connected individuals/communities' leaving a trail (of data) in the digital world. People use digital capabilities through many types of devices (such as desktops, laptops, smartphones as well as wearable devices

[1]We refer in particular to Gartner (Nexus and digital lenses concept) and IDC (3rd platform concept).

like smart-watches and e-glasses, etc.), thereby experiencing various kinds of interactions with computers. *Mobility* is a key access point to digital capabilities. And it is through these very same devices that people digitally connect with other people. *Online communities and social networks* represent digitally enabled network-based relationships of individuals. *Digital social business* realizes value creation from human-to-human digital connections. This digital key element, for the sake of simplicity, is generically referred to as *People*.

- From a historic perspective *businesses* have generally been run as self-optimizing entities placed in a static environment, being today compelled to continually evolve their dynamics in order to regularly self-disrupt and then renew themselves within constantly changing markets. The term 'Businesses' is used as an abbreviation for 'digitally connected businesses/groups of businesses' combining their digital capabilities with the aim of creating new solutions. These businesses digitally connect to other businesses, as well as to individuals and assets, while employing different types of digital means: the web, XML standards, connectors to marketplaces, and so forth.
- *Things* are no longer static objects, rather these are increasingly becoming parts of and in the digitally connected world, interacting smartly with people, businesses, or other objects. The term 'Things' is used as an abbreviation for 'digitally connected objects' or 'smart things'. Smart things are typically equipped with sensors producing data, while possibly even having their own application logic, exchanging data and connecting to networks. Smart things are able to automatically react to contexts without customer interaction. This can involve customers' smartphones provided these serve as smart sensors (e.g., for determining their current location). The category of Things also includes robots, autonomous vehicles, drones, etc. and also, any technology for digital manufacturing (as for instance 3D printing) using digital information for producing physical objects; these, too, would be part of the 'Things' category. The *Internet-Of-Things* (IoT) connects individual physical objects to have them interact with other objects, people, and businesses—creating value from the information exchange. The term *Machine-To-Machine* describes value creation from things-to-things digital connections.
- *Data*, from the perspective of technology, usually refers to records in databases and data management processes. However, data can also represent business assets (Van't Spijker 2014) one can leverage for a business model. The term 'Data', as a digital key element, is an abbreviation for real-time, complete, detailed, consistent, transparent, and accessible information, and for any algorithms employing these data for analysis, planning, and prediction—including cognitive computing. This description includes sophisticated analytics procedures that process small or large amounts of data and generate consumable information. Data also encompasses *Big Data* and *Smart Data*.
- *Cloud*, from a technology perspective, is just an infrastructure. From a digital business point of view it is also a value-creating *service* with specific characteristics, namely:

Business Model Components	Digital Key Elements
Value Proposition	Data
Customer Segmeets	Cloud
Revenue Streams	People
Channels	Business
Customer Relationships	Things
Key Partners	
Key Resources	
Key Activities	
Cost Structure	

Fig. 4 The two dimensions of digital value drivers

– A service that handles abstract resources (e.g., digital contents, or information associated to a physical resource/product, or a natively digital product).
– A service that is on-demand (i.e., available on request).
– A service that is scalable (up and down, depending on the demand).
– A service that you can pay-per-use (i.e., you can pay based on consumption).
– A ubiquitous service (i.e., accessible from anywhere).

In this way, the cloud becomes a service model and a logical shared environment to which people, businesses and things connect in order to exchange and accumulate data, as well as to offer and consume digital services.

3.2 'Digital Value Drivers'

For business, it is important to understand how digital capabilities generate value. To both consider digital capabilities and value, we have introduced the concept of digital value drivers. These are value-generating effects that come from digital key elements and can be assigned to certain components of the enterprise view. If we think of the components of the enterprise view and the digital key elements as two dimensions, we arrive at the matrix scheme as shown in Fig. 4.

Analyzing a variety of digital business examples, we have derived a list of digital value drivers. Table 1 shows three examples of digital value drivers.

Digital value drivers usually do not appear in isolation, they depend on each other. These relations are often important for the application, as we will see later.

3.3 Digital Business Model Design Methodology

Organizations wanting to explore the opportunities offered by digital business are to avoid leaping into the digital economy at random. There has to be a digital

Table 1 Examples of digital value drivers

Business model component	Digital key element	Value driver	Description	Example(s)
Value proposition	Cloud	On-demand services	Digitalization moves the information-related parts of physical products to abstract resources (de-materialization). Resources and services are offered on-demand, which helps balance demand and resources	Springer Science + Business Media offers more than 170,000 e-books; Netflix provides on-demand video-streaming
Customer segments	Data	Micro-segments	Detailed data on customers, and the aggregation of data on platforms, enables companies to target micro-segments and even individuals (segments-of-one). Based on the aggregation of customer data from various sources, a company can generate a profile that helps towards offering an individual solution. This allows companies to extend customer segments to customers with very specific demands	Amazon offers rare books to a segment of customers interested in them
Customer relationships	Cloud	Networked customer relationships	Due to the integration provided by the Cloud, companies can share customer profiles. In this way, companies get a more detailed picture of their customers, while customers get access to more solutions	Star Alliance airlines manage customer profiles and the 'Miles & More' loyalty program across different companies

strategy, based on implicit or explicit 'Strategic Focus Area', a strategy that guides the required business model analysis and (re-)design. The strategic focus areas describe a well-defined direction of development in the digital economy, one specific to the conditions of the company. Following a schema by Treacy and Wiersema (1993) we can identify three groups of strategic focus areas with respect to business model innovation:

- *Operational Excellence* (focus on value creation).
- *Solution Leadership* (focus on value proposition).
- *Customer Intimacy* (focus on value delivery).

Examples include:

- For Operational Excellence:
  - Leverage digitally enabled ecosystems.
  - Set up crowd-partnering.
  - Exploit new data streams as resources.
- For Solution Leadership:
  - Expand business from product to services.
  - Generate mass customization.
- For Customer Intimacy:
  - Simplify solutions to improve customer experience.
  - Expand global reach.
  - Intensify customer involvement.

In addition to strategic focus areas there is also another concept to help structure digital value drivers: 'Business Model Patterns' that have gained wide acceptance in business model design (Gassmann et al. 2014). The business model patterns emphasize a number of specific design ideas, and they detail them using companies having successfully implemented them as examples. Workshops have shown that employing these as patterns makes the transfer of ideas to new contexts easier. While strategic focus areas aim at the consistency of a digitalization initiative, patterns support the generation of design ideas. In this sense, we can regard configurations of related digital value drivers as micro-patterns, micro patterns, which help pin such ideas to digital key elements.

Business model patterns and digital value drivers differ in one central aspect: While business model patterns address the entire business model, digital value drivers focus on particular business model components and digital key elements; digital value drivers may therefore appear in various business model patterns. From this we are able to infer that business model patterns describe how digital value drivers can be smartly combined to explain the strength of a certain business model.

In practice, we combine the different concepts in various ways. For example, we might follow this sequence:

1. Use of digital business model patterns as a first access point for coming up with some initial ideas and a selection of certain patterns for further analysis.
2. Reflection on strategic intent, creating clusters from the idea design process while streamlining this with an eye for possible synergies.
3. Use of value drivers to clarify how technology is employed in the implementation of digital business model ideas.

Any suitable order and any repetition of the steps therein is possible. For instance, if the focus lies on a certain digital capability, we might for instance select value drivers related to that specific digital key element (e.g., cloud) or composite a digital key element (e.g., IoT). In another case, value drivers related to all digital key elements may be a consideration.

This threefold approach (strategic focus areas > business model patterns > digital value drivers) keeps the focus on the digital transformation throughout the business model design process, while providing leeway to also explore opportunities beyond digitalization.

4 From Business Model to Service Design

To further enhance the process from digital business model design to its implementation we then go beyond the 'Digital Business Model Design' methodology and support service design. To show that digital value drivers play a role in this respect, we shall sketch the main steps of this improved procedure and point out the connections. As an illustration for this methodology 'Quick Service Restaurants' (QSR), also known as fast-food restaurant chains are going to serve us as an example, one we have simplified for the sake of yet greater clarity.

The QSR industry segment recognizes a need to reinvent itself to fit the tastes of a younger (digital) generation, so the industry is always on the lookout for innovations of a digital nature. In this QSR example we concentrate on the customer order as a core process in this industry, while reflecting the specifics of customer interaction with respect to digitalization opportunities.

4.1 Deconstructing a Digital Business Model: QSR Example

Starting with a fictitious representation of the digital business model for a QSR (with a focus on menu selection via a digital service) we are going to use the digital value drivers to show how digital technology affects the business model. The example is guided by *Solution Leadership* as the main operational strategy, aiming at an improved customer experience during the visit at the QSR. A simplified enterprise view for the example is presented in Fig. 5. For each business model element, it shows a selection of relevant digital value drivers corresponding with a description of their respective realization. The symbols in the left upper corner of each block show the matching digital key element (lower icon) and the business model components (upper icon). Cloud-based process execution as the backbone for implementing all described digital capabilities is not explicitly mentioned but mandatory.

Usually we add arrows connecting the boxes in the diagram to indicate cause–effect relations between digital value drivers. Some of these relations, such as the connection between the digital value driver 'Data Management' and a key activity, are obvious; as are the way 'Data as Resource' describes a key resource required for data management, while other relations are less obvious and more varied. For

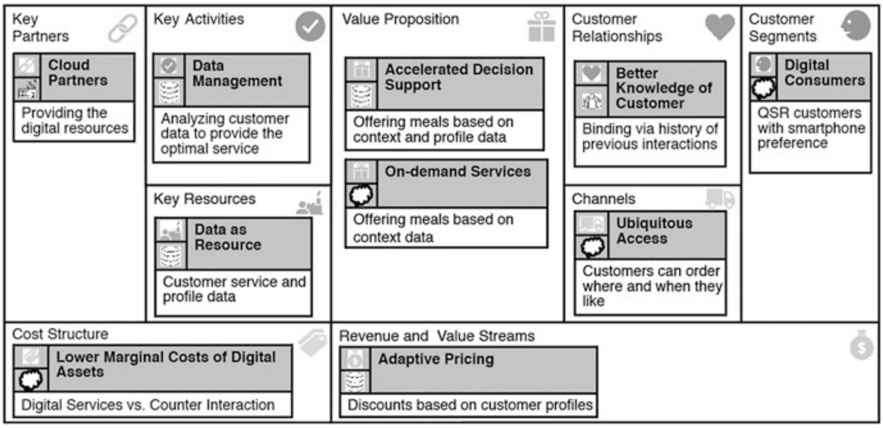

Fig. 5 Exemplary enterprise view for the QSR case

example, data processing may be based on the company's own digital capabilities or from those of a partner service. In this example, we have omitted the relations in Fig. 5 for the sake of simplicity.

4.2 Service Design Principles

The steps for designing a new offering implementing a digital business model are similar to the steps for standard service design. The major difference lies in considering relevant digital value drivers aimed at providing the customer with a digital-rich user experience. Although there are many different methodologies for service design, the most common and probably most effective one follows Design Thinking and enables to integrate digital business model and service design. After setting the design for the scope, the Design Thinking procedure goes through the following steps:

- Research—Get to know your users and their needs.
- Synthesis—Define *Personas* and baseline *Customer Journey Maps* and *Service Touch Points*.
- Ideation—Come up with new service ideas.
- Rapid Prototyping—Design a high-fidelity prototype of the new service by defining new *Customer Journey Maps* and *Service Blue Prints*.
- Validation—Validate the new service for feasibility, desirability, and viability.

The following sections present two of the Design Thinking steps in service design to illustrate the relevance of digital value drivers for service design.

4.3 *Service Design Building Blocks for the QSR Example*

4.3.1 Persona Development

Service design requires a deep understanding of service users and their explicit or tacit needs. Every service addresses more than one user and probably more than one user segment, but to understand *how* a service fits the users' needs, we have to elaborate a very specific Persona that reflects the person who is going to consume this service. Good practice is defining at least one Persona per user segment.

The Persona description must be as authentic and detailed as possible; these details are to highlight the role of digital value drivers, describing their influence on the Persona. The interaction with digital technology must be perceived as natural, providing the designers with sufficient details, so they can understand the Persona's interaction with a specific digital feature.

Figure 6 describes the personas for the QSR case: a family (i.e., a couple with two young kids), who are looking for a place to have lunch during their weekend trip to a shopping mall.

The Personas help us understand how the digitally enabled value proposition fits the family's needs because the concrete setting makes the effect of a digital value driver more comprehensible. For example, with respect to the digital value driver 'On-Demand Services' we see that a mobile app could enable the Persona to make a faster food order (anytime and from anywhere, by using a cloud-based digital service). In a similar way, we realize that the digital value driver 'Tailored data-based customer solutions' of a new offering can help leverage selected user preferences (e.g., low-fat menus known from previous transactions) and promote specific offerings to the identified customer.

4.3.2 Customer Journey Map and Service Blueprint

Another important building block in any service design is the customer journey map, which describes the sequence of interactions the customer follows when consuming the service. It is complemented by a 'Service Blueprint' illustrating the service from the perspective of the service provider. It encompasses all subsequent tasks the infrastructure has to execute below the customer's line of visibility. A service blueprint adds supporting processes (activities) and resources enabling the service provider to provide the service to the customer. While the customer journey map (see Fig. 7) has a stronger focus on the business model elements that reflect the value aspect, the service blueprint takes digital capabilities into account. The digital value drivers appear as mediators between both.

'Cloud-based process execution', for example is a digital value driver pointing towards both the key activity 'Data Management' and the digital key element

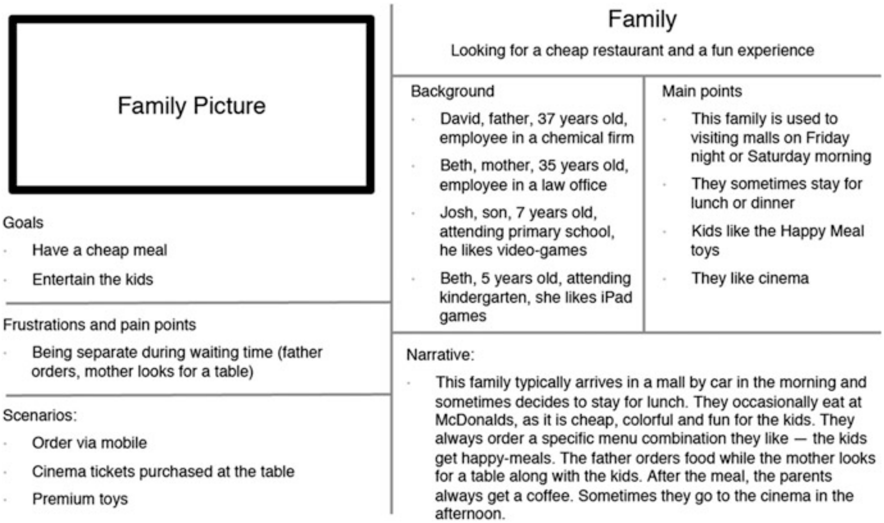

Fig. 6 Persona for the QSR case

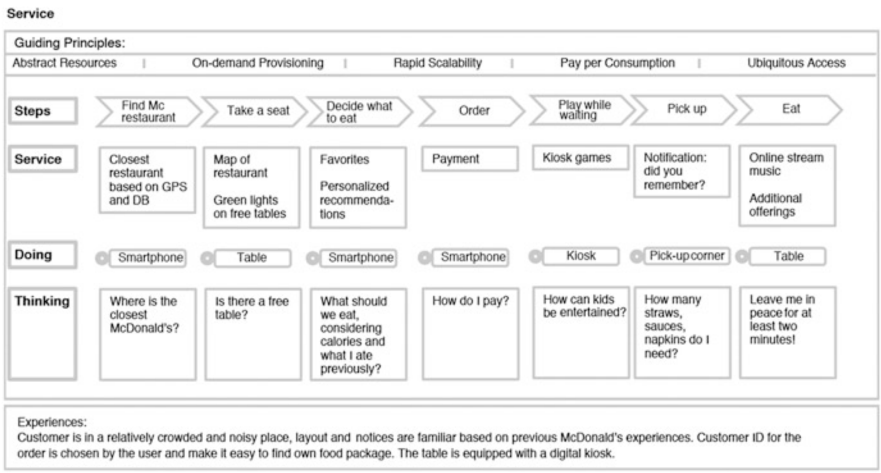

Fig. 7 Customer journey map (partial)

'Cloud', describing the technical characteristics of the new service. In the same way, the value driver 'Data Management' describes a key activity based on the technical processing of the available data, which we can leverage to manage the user's preferences and past transactions.

5 Conclusion and Key Learnings

In response to the challenges of the digital economy we need more than just tools to systematically develop digital technology; what we need is a methodology for systematic Digital Business Modelling based on a language both business and technology experts equally understand. The structured approach we have presented in this chapter is a step in this direction. Additional research and practice is nonetheless needed. Considering the increasing importance of digital business models for modern enterprises and the fundamental changes they cause, we assume that the proposed concepts will also affect future corporate management. Realizing the changes that the digital transformation has already caused, we have to reconsider our thinking of how to run business in general.

Key Learnings

- Digital transformation requires a methodological approach that incorporates technology and business considerations in an integrated manner, and it is to be based on a common language for technical and business experts.
- The concepts of Digital Key Elements, Enterprise View, Digital Value Drivers, and Strategic Focus Areas provides such a language.
- Applying Design Thinking to the Business Model Development and Implementation methodology, extended by the concepts, fulfills the requirements of incorporating technology and business considerations.

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Michael Blaschke studied Management Information Systems at universities in Germany and South Korea. He is a research assistant and Ph.D. candidate in a joint program at the University of St. Gallen (HSG) and the SAP Innovation Center St. Gallen. His research mainly focuses on business model based management, digital transformation, business ecosystems, and value-aware information systems.

Marco Cigaina is a program manager in SAP service innovation group focusing on innovation management and research. He has a degree in engineering and his experience includes technology, business intelligence and enterprise architecture consulting. He is the author of the book 'Innovation Management Framework: Enabling and Fostering Innovation in Your Company' (published by Epistemy Press, 2013).

Uwe V. Riss has a degree in mathematics and a Ph.D. in natural sciences. He is the author of various scientific publications in knowledge and information management with a focus on semantic technologies and knowledge work. His recent research focuses on business model innovation and digital business.

Itzhak Shoshan has a bachelor's degree in Computer Science and M.B.A. from IDC Herzliya. He is a PMP-certified project manager in enterprise architecture (Certified TOGAF) and a practitioner of innovation techniques like Design Thinking, Lean Startup, Business Model Canvas, Systematic Innovative Thinking and Product and Service Design.

Part II
Industry-Specific Trends

The Unbanked Don't Need More Brick and Mortar Banks

Henning Kehr, Graham Tonkin, and Reiner Bihler

Abstract 'Disruption' is a word used more often as we see digital solutions solve age-old problems with a substantially cheaper and more convenient product than the one in place. Whether in communication, ride-sharing, or nearly any other industry, the implications of quickly evolving technologies have added complexity to traditional businesses, which find it difficult to keep up with such rapid advancements. The cost of building brick and mortar networks across large, sparsely populated areas with low household incomes is not economically viable and has led to the exclusion of two billion people from accessing financial tools such as savings and investment accounts. New technologies, such as the bitcoin blockchain, appear to be a viable solution in a lucrative position to revolutionize the financial sector just as the internet revolutionized the communication sector in the early 1990s. By using a combination of new technologies, including the bitcoin blockchain and cryptofinancial technologies, financial service providers have the opportunity to offer full financial services to an entire population without having to build a single physical bank. Because of the added security and the possibility of risk-free finance, customers will be able to make low value transfers under $0.01 to anyone, anywhere, at nearly no cost. The internet has made worldwide communication cheaply, easily, and instantly accessible for nearly everyone on the planet. A new era of mobile services using crypto-technologies has the ability to do the same for the financial sector.

H. Kehr
University of Applied Sciences Worms, Worms, Germany
e-mail: kehr@hs-worms.de

G. Tonkin
Monetas, Zug, Switzerland
e-mail: graham.tonkin@monetas.net

R. Bihler (✉)
SAP Deutschland SE & Co.KG, Walldorf, Germany
e-mail: reiner.bihler@sap.com

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1 Introduction

New cryptographic technologies, along with the bitcoin blockchain, can lower the costs associated with traditional financial services, and allow emerging markets to avoid investments in a costly brick-and-mortar banking network while expanding financial services to every citizen with access to data coverage.

Mobile financial services have grown rapidly in recent years, most notably with the success of Wizzit in South Africa, G-Cash in the Philippines and M-Pesa in Kenya (Mohan and Potnis 2015). Although an estimated 75 % of adults in Kenya use digital cash, more than 98 % of transactions are still conducted using physical cash. Users enjoy the convenience and safety that of mobile banking, and the ability to remit easily and cheaply both from urban cities where Africa's middle class is quickly growing, to the rural villages where family members reside. Cash is still a requirement, however, due to the difficulties that arise from using mobile money for low value day-to-day transactions. Fees are prohibitively expensive where payment volume is highest (below USD 5), causing users to avoid transacting in the digital system in favor of physical cash, despite the increased risk. In addition to the prohibitive cost, mobile financial services are further limited by a lack of interoperability and the inability to send money to users on a different mobile networks, or in a different country.

Advances in financial technology (FinTech) are focused on delivering financial services to the unbanked by utilizing a hybrid of blockchain and off-blockchain technologies aimed at lowering distribution costs and allowing for the delivery of full financial services digitally for the first time.

Many countries have put forth policies and created long-term goals centered around transitioning to a cash-light society. Although perceived by consumers as not having a fee, economies are burdened by heavy cash use. In an age in which the younger generation is born with smartphone in hand, there has to be a solution for money and value in a truly digital world. Current financial technologies are antiquated, and the burden of adapting and creating better efficiency using centralized card payment technology is unlikely, as traditional card services have failed at expanding coverage to the unbanked in the last 60 years. With mobile phone ownership so widespread, mobile banking technologies have been growing quickly. In the last decade alone, mobile banking has been able to connect more people to financial services than legacy banks have been able to do in the last century (GSMA 2016b). Progress has been impressive, but certain limiting factors have presented mass adoption and further uptake. New cryptofinancial technologies are able to solve these problems, and allow for ultra-secure digital payment methods that demonstrate the first credible technology that will allow entire economies to go cash light for the first time.

2 The Market

Mobile financial services continue to expand as the cost of mobile phones, particularly smartphones, continues to fall. Most sub-Saharan countries now have mobile networks with a network coverage exceeding 95 % of population coverage, and companies are quickly realizing the potential to connect directly to their customers (GSMA 2015b). Smartphone penetration is rapidly increasing, reaching thresholds of around 80 % in most mature markets. Less than 10 years after the release of the original Apple iPhone, low-cost smartphones from Asia are struggling to keep up with demand in emerging markets. Costs are continuing to fall even as the performance of devices increases, and many manufactures now have mobile devices available for under USD 50. Mobile network operators are seeing revenue from voice and SMS calls fall as users recognize the value for over-the-top services such as Facebook and WhatsApp (Sahota 2014). Today there are an estimated 400 million mobile money accounts worldwide, 50 % of them having being added over the last 2 years alone (GSMA 2015a). Google's ambitious plan to cover the globe with high-speed data access is coming to fruition with the announcement of their first deployment of the Project Loon, which involves high-altitude balloons in the stratosphere over Sri Lanka, effectively covering the country's 20.5 million people with high-speed internet. Subsequent deployments aim at providing coverage across many additional countries (Fried 2016). The stronger growth will be for wholesale payments and developing countries (Dab et al. 2015). Google isn't the only company interested in creating a truly global internet; Facebook, by developing autonomous drones acting as Wi-Fi hotspots for large geographic areas, and SpaceX, by aiming at having a network of low-orbiting satellites, are looking to create truly global internet coverage.

2.1 Cash

Cash is expensive, inconvenient, and carries risks, but it remains the currency of choice across most of the globe. Even in Kenya, where M-Pesa (the world's most successful mobile money platform) was implemented, more than 98 % of transactions are still hand-to-hand transfers (Collins et al. 2012). Consumer confidence in physical cash is high because of its fungibility; users never run the risk of a transaction failing because cash is not accepted.

People do not typically consider cash as having a transaction cost, as those costs may not be inherently apparent. However, real costs to the cash economy do exist. First, cash is restrictive. In a cash-heavy society, a considerable amount of transaction friction stifles economic growth and limits individuals to markets in which they have to participate physically. With cash, all transactions need to be made locally, exposing the user to an increased risk.

Additionally, cash is expensive to produce, secure and distribute. The total cost of printing, distributing, and securing paper money burdens governments, which might else prefer to use their limited funds to improve health services or education (Chakravorti 2014). What customers perceive as a fee-free transaction is actually shifting resources away from better and more effective uses. Liquidity is also a common problem in many small sub-Saharan towns, as the cost of creating metal coins in turn limits their production and distribution. People in small villages often spend considerable amounts of time looking for metal coins and then accumulating them because of increased usability (Anyango 2011).

Banking networks have had difficulty adapting to their markets, as the cost of building physical locations is prohibitively expensive in areas of low population density; especially in a poor country where deposits made locally won't make operations economically feasible. In these areas, access to sources and stores of cash are few with long distances between them. Public sector employees and individuals who receive social benefits or government salaries may need to spend a considerable amount of time each month traveling to bank branches in larger towns to withdraw paper money and then take it back to their villages of residence. The loss of productivity thus incurred is substantial, even without accounting for additional risks such as loss, theft, or fraud.

Apart from the inconvenience and expense, consumers are exposed to considerable risk when using cash. The transportation and safekeeping of a month's salary exposes household to loss, theft, and the fate of bad budgeting. Business-to-business transactions often involve suitcases full of cash, time and again brought across national borders and through various police checkpoints, hidden in private vehicles.

The economic strain imposed by cash stifles growth in markets where people are most in need of financial security and subject to insufficient food supplies. There are many other problems associated with cash, including the loss of the functionality for investments, and having to face the threats of inflation.

2.2 Technology Diffusion in Africa

The pace of technological diffusion is continually becoming more rapid as digitization decreases, and Africa is no exception. Although much of sub-Saharan Africa has an underdeveloped infrastructure, power grids and roads being two examples, the commercialization of the telecommunications sector has nonetheless led to advancements that allow many markets without established fixed-line infrastructure to leap frog with the most advanced telecommunications software. While in mature markets most of the people now use smartphones, in African countries a large number of under- and unbanked population have access to financial services using basic and cheap mobile phones. (KPMG 2015) The resulting low-cost alternatives allow for rapid adopting, as demonstrated in Fig. 1, as the general population gains access.

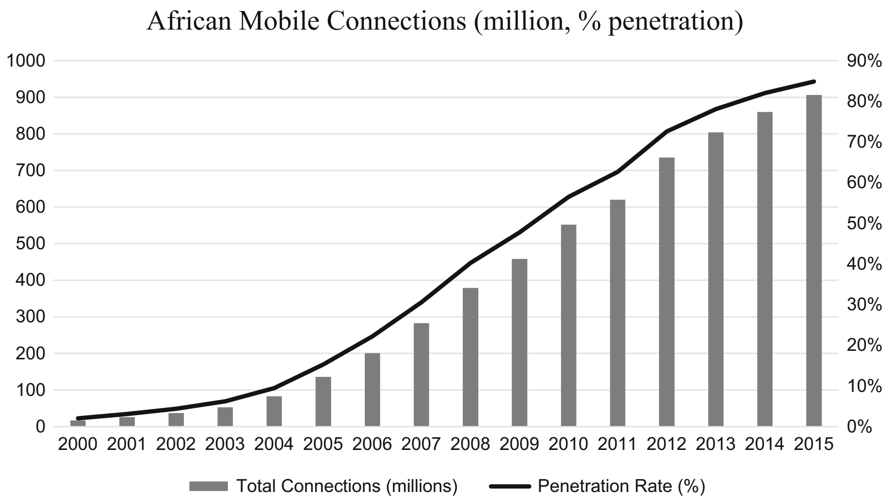

Fig. 1 Sub Saharan Africa will soon see full market saturation in the mobile market (adapted from Evans 2012)

2.2.1 Hardware

Sub Saharan Africa has benefited from technological diffusion because of an ability to invest in new technologies, which do not require the infrastructural investments requisite for many stages of development in Europe and North America. A good example of hardware adoption that allowed many developing countries to enter the market with the most recent technology is in the telecommunications sector. Unlike Europe, sub Saharan Africa did not have fixed phone lines connecting populations, and communications technology was available to most small villages for the first time through mobile networks.

Citizens in these countries benefited because the cost to access the services was greatly reduced over traditional fixed line services, mainly due to distribution costs (wireless infrastructure versus fixed line). In combination with low-cost mobile phones, implementation happened on an unprecedented level. Mobile phone adoption happened swiftly, and markets grew from <2 % of telephone use, to over 80 % in under 15 years (Odunuga 2014).

2.2.2 Software

Once low-cost smartphones had become available and distribution networks established, the ability for customers to access software applications led to their rapid adoption and to an explosion in data services, as seen in Fig. 2.

New applications reduce communication costs, applications such as Viber for VoIP calls, and WhatsApp replace SMS based messaging; both were quickly

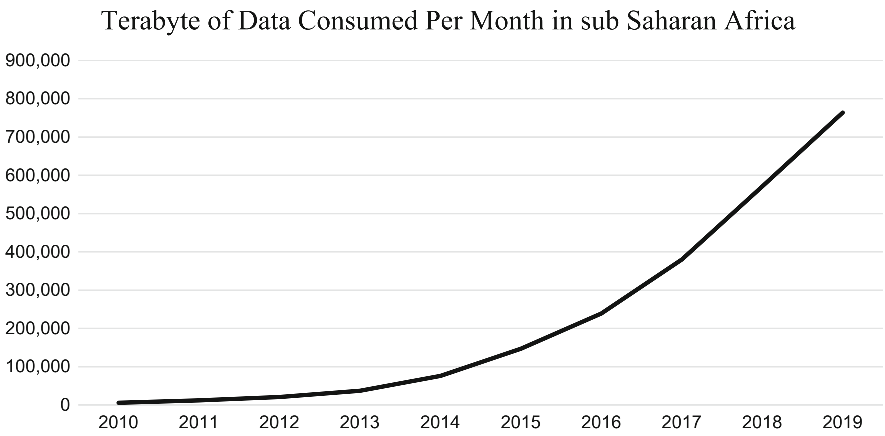

Fig. 2 As users recognize the value of over the top services, data traffic is expected to surge (adapted from Odunuga 2014)

adopted as customers came to see the cost saving potential and ability to communicate regardless of national borders. It is estimated that data traffic alone will increase by a factor of 20 in the period between 2014 and 2019, as the cost for smartphones falls and users see the value of applications available (Odunuga 2014). Facebook has reported that half of all internet users in sub Saharan Africa have a Facebook account; a remarkable 100 million people (Boorstin 2014). The distribution cost of software is negligible, so companies such as Facebook and Google have seen the need to have low-cost internet access as a means to allow greater adoption. As more and more have access to the internet, and prices fall even further, the ability to have a software application accessible by seven billion people without having a brick and mortar presence changes the dynamics of distribution and will allow for small companies to scale at an unprecedented rate.

2.3 M-Pesa

The most successful and all-encompassing digital currency comes from a place least expected: a middle-sized sub-Saharan African country, Kenya. Mobile financial services have been growing rapidly in the last few years, increasing from four providers in 2009, to 271 in 2015. Between 2012 and 2015, an estimated 250 million new mobile money accounts were opened globally, bringing the total users to over 400 million (GSMA 2016b).

The mobile money service M-Pesa (Pesa is Swahili for ‘money’) was introduced after consumer behavior was recognized as an opportunity to increase customer loyalty in mobile financial services. Over 99 % of cell phones in sub-Saharan Africa are pre-paid and require the purchase of credit (Statista n.d.). A customer can go to the vast agent network: a friend or acquaintance who receives a small commission for selling credit from mobile networks. The credit, once purchased from the agent, is sent to the buyer's phone for immediate use. Customers tended to buy pre-paid top-up cards, and simply enter the code in an SMS addressed to the intended recipient. The family member could then directly receive that money in the form of call time on his or her device.

Market conditions in Kenya were key for the introduction of mobile financial services due to a variety of factors. The rapid urbanization of Kenya's major cities by an educated youth meant a bifurcation in demographics: cities filled with young, low-responsibility workers with middle class incomes, and a working class population relying on subsistence agriculture in rural villages. This demographic shift was complemented by two environmental factors: an increasing feature-phone adoption rate in rural areas, and difficult travel conditions due to political instability. This perfect storm of events produced the first urban adopters of mobile financial services: educated employed young people, who then became the conduit for the rural reaches of Kenya. To avoid the long trips home, these early adopters quickly coached family members in rural villages to set up and use their M-Pesa accounts; these were offered by Safaricom, the mobile network which operates the mobile money service.

Since its inception, the growth of the M-Pesa has been staggering. Today, there are over 150,000 Safaricom agents who help customers add or withdraw money from their accounts, buy airtime, and complete a variety of other functions (McKay and Mazer 2014). Safaricom has increased their value-added services, allowing customers to pay utility bills, satellite TV subscriptions, school fees, and a variety of other items using the digital currency. In addition to payments, other financial services, such as savings and loan vehicles, have connected many to their first financial services. Other mobile network operators have taken notice of M-Pesa and have created their own mobile money solutions. Uptake elsewhere, however, has not yet been able to achieve success on the same scale as the M-Pesa, primarily because 80 % of mobile users in Kenya subscribe to Safaricom. M-Pesa is only able to transact with other customers on the Safaricom network, which has allowed for quick adoption in the monopolistic environment but has also limited the ability to be replicated in other markets where lack of interoperability limits the potential for customers to transact with one another.

3 The Challenges that Limit the Growth of Today's Mobile Financial Services

Although it is estimated that mobile financial services have been expanded to well over 100 million unbanked—or under-banked—people in the last decade, success has been limited and the industry is still in its infancy (Ernst & Young 2014). As the market expands, several problems have become evident, limiting a wider adoption.

3.1 Interoperability

The success of M-Pesa, due in part to Safaricom's large market share in Kenya, has led to other firms attempting to increase customer loyalty through the creation of their own mobile money platforms. However, throughout sub-Saharan Africa, only a handful of platforms are interoperable with other networks, or able to send money across national borders. Thus, consumers are limited to sending money only to those who use the same network.

In developed markets, consumers expect to be able to transact between different banks. Mobile financial systems need to be brought up to the same standards. Mobile network operators have begun to establish some contractual relationships to allow for money transfers across networks, and sometimes across borders, but these contracts still require citizens to be fully informed consumers, able to analyze the combination of networks that would most benefit them. Interoperability issues must be solved, but doing so will only solve one problem that contributes to a larger series of issues limiting growth.

3.2 Regulation

Banks and national governments have become aware of mobile network operators offering financial services, and banks have acted as expected whenever a new competitor enters the industry: with resistance (Obera 2012). Banks in Kenya, for example, have argued that mobile money operators should be treated with the same scrutiny as banks; this requires more stringent regulation and and tighter Anti-Money Laundering (AML) and Know Your Customer (KYC) controls. These controls are in place to stop bad players from using the technology in malicious or mischievous ways, controls often created by western regulators and replicated in markets around the world. This replication and standardized regulation often raises the entry barriers and stifles adoption in many markets still struggling to increase financial inclusion. In Kenya, however, the lawsuits put forth by the banking sector were met with a strong response by the Central Bank, which ruled in favor of mobile networks and against these controls. Safaricom involved the Central Bank from the early days of development, ensuring compliance with the implementation and a favorable regulatory environment.

Economic growth in Africa has historically been stifled by well-intentioned Western AML regulations. The specific African context was not considered when these regulations were crafted, leading to barriers for the unbanked around the world. Farmers and small business owners often work regionally, and the difficulty of sending money home after a seasonal job exposes the bottom of the pyramid to higher costs and more risk (FATF 2011). Banks continue to ignore the bottom of the pyramid because of the increased effort and AML and KYC costs associated with managing low-balance accounts. Using a risk based approach to AML and KYC will allow for the barriers to entry to remain low, while delivering the same level of scrutiny required for higher value payments.

3.3 Cost

Every mobile money platform today requires the presence of physical cash. A user can exchange physical cash for the digital equivalent, and send it to other users on the platform. Once the receiver has the funds however, they immediately 'cash-out', or exchange the digital value back to physical cash. This process has made mobile money used primarily for a single corridor of use, and has ignored the benefits of a wider digital ecosystem. People primarily use mobile money for single monthly payments, averaging around $33.

It has not, however, allowed mobile money to be used as a primary means of transacting. This model still has all of the negative externalities of cash because a user still must withdraw the physical cash to complete day to day transactions. About 80 % of the transaction volume in Kenya happens below USD 5, with 50 % being below $1 (Collins et al. 2012) as demonstrated in Fig. 3.

The bulk of the national payment volume consists of individuals purchasing things at their respective markets, buying goods or making other typical day-to-day purchases. Fees to transact at these low values often exceed 5 %, and are sometimes even in excess of 30 % with some providers as shown in Fig. 4. Because of this, people recognize the value in sending large value transfers, but still have to resort to physical cash for the majority of their transactions.

4 The Solution

The world's unbanked can substantially benefit from the transition to a cashless economy. However, the current marketplace has not yet been able to conquer the pervasive system problems. The ability for a paradigm shift towards cash-light and mobile based banking is not possible with just one of the previous problems being solved, but must have all aspects solved simultaneously.

Typical in many industries, it is not the largest companies looking to innovate, as the fear of self-cannibalization and heavy bureaucracy within large organizations make the ability to develop innovative technologies difficult. New FinTech start-ups are finding creative ways of using the bitcoin blockchain and cryptofinancial technologies to find solutions. These firms are working to reduce costs and transition the financial sector into a fully digital model for the first time. Many people are familiar with bitcoin operating as a currency, and while the term does refer to a coin or currency that can be used to store value or complete transactions, that usage represents only half of the bitcoin story and the innovation. The truly revolutionizing principle of the bitcoin lies in its method of

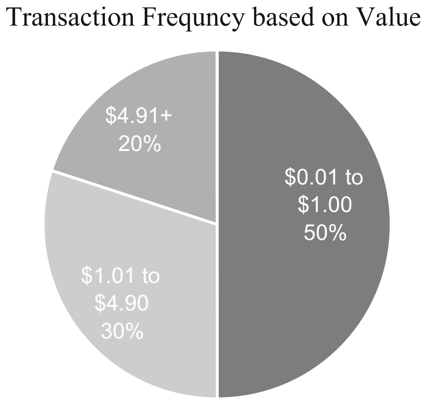

Fig. 3 While the average transaction on M-Pesa is USD30, 80 % of payment volume takes place for <USD 4.90 (adapted from Collins et al. 2012)

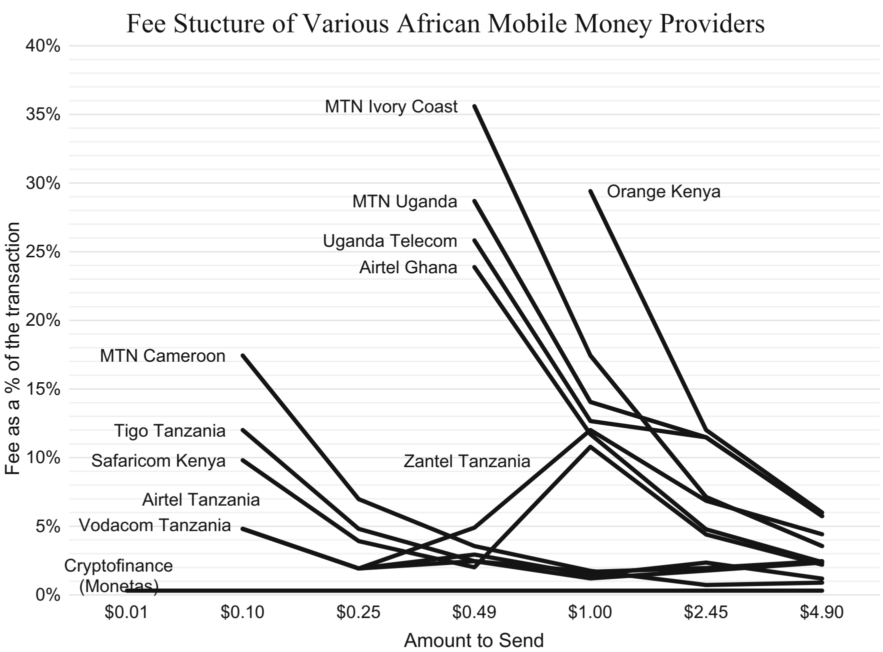

Fig. 4 Unpredictable and unaffordable fee structures where 80 % of payment volume occurs forces users to withdraw physical cash for day-to-day purchases (fees compiled from various telecom websites)

recording and authorizing transactions—the blockchain, which is commonly accepted as stable, unalterable, and inherently secure. FinTech firms are utilizing this bitcoin technology in a different way: primarily as a decentralized, global ledger.

4.1 The Blockchain as an Asset Layer

The security and functionality of the bitcoin blockchain can be utilized without being exposed to the negative aspects of the currency, such as price volatility. The blockchain is a decentralized global ledger that is publically auditable and secured by a network of computers with an overwhelming amount of processing power.

Ownership of anything, not just bitcoins, can be recorded on this public ledger. Once ownership is recorded on the blockchain, it can be traded by individuals as a 'receipt of ownership', or bearer instrument. Whether ownership of a share in a company, or a home mortgage, once an item exists on the blockchain it can easily be identified, managed, and traded without the need for a trusted third party.

When a central bank or mobile network operator (MNO), issues a national currency on the blockchain, it is conceptually similar to issuing and managing paper money. Until the second half of the twentieth century, bank notes operated as receipt of ownership of gold, known as the gold standard. Although physical notes were redeemable for the equivalent value in gold, most users saw greater fungibility in the trade of paper money and never withdrew precious metals. Similarly, a cryptographic token is redeemable for the real-world asset it is backed by. However, most tokens are traded electronically, as this is easier than transferring an actual mortgage or some other asset. Anybody who has a certificate can trade it freely (in its digital form), or return to the bank or any exchanger, if they decide to transact using paper money instead. Using the blockchain as an asset layer allows people to know that assets are recorded and auditable, impossible to counterfeit, and able to transact globally across mobile networks and borders.

4.2 Drawbacks: The Bitcoin Blockchain Is Not the Ideal Transaction Medium

Defining ownerships on the blockchain is incredibly useful, as it uses the security of the decentralized network to create a proof of ownership that cannot be forged or altered maliciously. Using the blockchain to transact, however, is slow, expensive and publicly auditable. The bitcoin blockchain has a capacity of about 7 transactions per second. Compared to M-Pesa's 900 transactions per second, and Visa's tens of thousands, the blockchain has a fatal flaw that stops it from handling the globe's transactions—the minimum verification time of 10 min, with high-value transactions often taking much longer than that.

Additionally, the bitcoin blockchain is expensive. A single transaction on the blockchain costs more than USD 5 (Blockchain Info n.d.). The user does not pay these fees; instead, miners, who work to secure the decentralized network, are compensated with 'block rewards', the blockchain's way of creating new bitcoin. Over time, as the block reward decreases, fees per transaction are likely to increase, to compensate for the work of miners securing the network.

4.3 The Decentralized Transaction Layer

Mobile financial systems can solve many of the problems of cash, and the blockchain has the ability to solve many of the problems of the mobile financial system. But in what ways can the problems of the blockchain be solved?

Recent advancements in hardware and software technologies have allowed the development of new technologies to act as a hybrid solution that utilizes both blockchain and off-blockchain technologies to solve many of the issues that are currently associated with mobile financial services.

One example is Monetas, a FinTech start-up based in Switzerland. Monetas has developed a new type of software modeled on the notary public, a concept that dates back to ancient Egypt. Like a notary, the software is not a financial intermediary, and cannot affect the value in a wallet. It instead acts as an impartial witness, ensuring the parties involved are validated (through their cryptographic key pairs); the terms of the contract are then met.

This breakthrough in cryptographic software can transact any type of financial contract, whether a national currency, an investment, a complex derivative, or an automated contract; without the software alone having the ability to modify a balance. Because security is built in to the very design of the software, it is only possible for the holder of the cryptographic key pair to modify their balance. Because this notary public system operates outside of and above the blockchain, it is not subject to the same speed and cost constraints. This system is instantaneous, secure, and can transact real time gross settlements at negligible cost, around the globe.

5 The New Era of Mobile Financial Services

Combining blockchain technologies and off-blockchain technologies can change the way our mobile financial services can be accessed in today's brick and mortar world. The bitcoin blockchain provides an incorruptible, globally available, public ledger with perfect uptime that can record the issuance of anything, including fiat currencies, global capital, commodities, or nearly any type of asset.

A decentralized transaction layer allows for goods to be traded instantly, globally, and cost effectively. In much the same way that communication was revolutionized with the adoption of the internet, these technologies will provide the world with a much more accessible financial system.

With the ability of an individual to send even sub-one-cent transactions to anyone anywhere on earth using a smartphone at negligible cost, words like 'remittance' will become obsolete in much the same way as 'long distance email'. Comparing cryptofinance and legacy finance will be like comparing Whatsapp and physical mail. The latter was made functionally obsolete by the ability to message anyone with the world's first global distribution platform- the smartphone. Making borders irrelevant, data services made global communication possible at nearly no cost, instantly. Cryptofinance will solve the issues which have left nearly two billion adults excluded from the financial system by bringing transaction and distribution costs to a negligible level, while allowing more complex financial products to be available to anyone, anywhere, with no infrastructural investments. The new role of financial institutions will be to create the best-targeted consumer products, adding stability through financial services to the bottom of the pyramid for the first time; for example, for rural farmer selling a futures contract for his corn, or a young girl saving for education with an investment portfolio that is diversified and invested in global equity markets. As in many industries, it will not be proprietary market knowledge, experience, or market-share that drives the evolution of business models from the pre-internet era to a hyper-connected world. It will be the software engineers and the ability of companies to leverage digital products and services, which cost nearly nothing to distribute or replicate, that will be the future of finance. Today these technologies seem far-fetched, and create concerns of consumer safety, knowledge, and usability. These lingering questions must be answered by financial service providers willing to put forth the investments needed in user design, market research, as well as in the algorithmically managed investments that generate low-risk returns for customers wanting to avoid high inflation in their physical location.

Although there is much concern about what a globally inclusive economy will look like, much of these concerns resemble those of skeptics in the early days of the internet. A globally decentralized communication platform was perceived as a threat because of its ability to let anyone, good or bad, easily communicate and share information globally. Ultimately, the internet proved to be one of the most empowering tools humanity has ever seen. The total value added to the lives of billions far outweighs the negative consequences. Bringing the same decentralized concept of finance has the ability to allow sovereign control of wealth to drive individual prosperity. It is important, however, to note that the benefits are extended to all parties involved.

5.1 Benefits for Governments

The digitization of assets, and transition to a 'cash-lite' society is an aspiration of many societies and has obvious benefits for nation states. Cash, as explained above, is expensive. The United States dollar is estimated to cost the U.S government as much as USD 400 billion in forgone taxes through under-the-table cash transactions (Chakravorti and Mazzotta 2014). In a cash-lite society, governments can implement analytics to better identify fraud and corruption, greatly reducing the cost associated with cash, while being able to focus on creating a hyper-efficient economic system that can keep up with post-globalization.

5.2 Small- and Medium-Sized Enterprises

For SMEs, doing more business digitally means increased revenue, and decreasing the costs associated with convenience and security. Digital assets can be sent to a supplier without the long trips with duffle bags of cash, which are common in sub-Saharan African markets, or invested in a savings account that diversifies risk across different currencies and markets. When the assets are invested digitally, revenue and financial security are greatly enhanced over today's model of trying to secure cash under the table. Digital assets can be invested in global products, insurance, or other tools that help to diversify risk.

5.3 Benefits for the Individual

Citizens gain sovereignty and empowerment through a decentralized financial model: individuals have ultimate control over their own assets. Recently, many citizens in Greece may have found this quite helpful, after the Greek government imposed restrictions on cash withdrawals and forbade users from using their own money to purchase goods and services. Although most people with a bank account believe they are in control of their assets, in a centralized model (such as today's financial system), it is the bank that owns the assets. The individual owns the bearer instrument, whereby the bank is trusted to repay the debt that is owed to the depositor. An individual on the Monetas platform has the cryptographic keys, meaning that the money is truly in the hands of the individual, similar to cash. This allows for greater independent sovereignty, especially for individual citizens who want to retain their wealth during times of economic instability during which banks may consider using private savings in order to fund bail-outs.

The biggest opportunities for financial inclusion from a shift to electronic payments have yet to be brought about in many places. There is tremendous revenue potential for financial service providers using the digital information generated by e-payments and receipts to form a profile of each individual customer (BFA n.d.). This digital (risk) profiling enables providers to offer more appropriate and relevant customer-specific products. Even beyond the use of e-payment records, businesses are starting to use other 'digital footprints', such as mobile phone calling records and social network traffic to offer credit to targeted groups. Using analytics to create a risk profile can change how lending is done, and will help provide loans to the billions who do not have an established credit history, or even a bank account. The creation of risk models done in the right way can make global peer-to-peer lending a reality, with individuals in developed markets directly lending to small business owners in emerging markets who have proved their credit-worthiness through the historical data associated with their accounts. The lending can take place without the middleman and make lending cheaper than ever before. Globally accessible peer-to-peer lending may lead to more-integrated equity invested across borders, which stabilizes the system, distributing risk more equally.

5.4 *Disrupting Current Technologies*

Having the potential of lowering operating costs to negligible levels while tremendously increasing functionality, current mobile money operators must prepare themselves for the new era of full mobile financial services. If history has taught us anything, it is that successful businesses are characterized by a dynamic business plan allowing them to become multi-generational. There is great opportunity for mobile networks to increase the functionality and use of their platforms, and for banks to contend through their own financial applications. Companies will need to compete for customers with value-added services, such as lending tools, savings accounts, and other products that their customers may value.

There are always companies failing to adapt to new technologies upon entering the market. Often, the companies with the largest market shares fail to adapt their business models, allowing the most innovative and efficient competitors to grow.

The world will be a very different place once every individual can securely store and transact value. This will be the first step towards the elimination of poverty; the wealth created by an increase in market participation will have a deep impact on humanity. By utilizing these new cryptofinancial tools, anyone with a smartphone will be able to exert greater power over their lives through the ability to be in control of their wealth. Distribution costs will be drastically reduced when a brick and mortar network is no longer necessarily required; and they will be further reduced by having compliance and security built into the software—eliminating the possibility of counterfeiting, charge-backs, and the other costs that weigh on a centralized solution.

6 Conclusion and Key Learnings

The great success so far in mobile financial services is just the beginning. The financial services sector will be impacted by digitization much like nearly every other industry. Current legacy technologies are limited and have excluded billions from connecting to financial services due to various barriers to their entry, among these are costs and regulations designed for mature markets. Despite three quarters of Kenyans using mobile money, nearly 99 % of the transactions are still in cash. Cost where payment volume is highest, and the inability to transact across mobile networks or national borders has greatly limited further uptake. New cryptofinancial technologies such as the bitcoin blockchain solve many issues limiting uptake, most notably the drastic reduction in cost that will allow for societies to transition their economies into a cash-light environment. Much like the internet allowed anyone on earth to communicate cheaply, easily, and instantly, cryptofinance has the same potential to allow for the hyper-connectivity to bridge communication with finance.

Key Learnings

- Because of the high cost of establishing a brick and mortar network through a large sparsely populated area, mobile financial services have grown rapidly in emerging markets in the last 5 years through the ability to offer low-cost financial products.
- Today's mobile money platforms are prohibitively expensive where 80 % of payment volume happens (below USD 5) in sub Saharan Africa and requires people to withdraw physical cash. New cryptofinancial technologies will allow for cost to be cut by an order of magnitude while enabling global peer to peer payments.
- A shift towards mobile-based banking and other technologies in the context of a developing country is only possible after addressing the cultural issues and taking into account the economic and political environment. While such problems as heavy bureaucracy prevent the development of innovative technologies, this issue can be addressed through collaboration with both private institutions wishing to increase convenience and functionally for customers while lowering cost, and public institutions focused on increasing financial inclusion.
- Limitations of today's technology and regulations to prevent money laundering have raised the barriers for entry and are restricting their use in developing countries.

  New technologies such as the bitcoin blockchain and off-chain cryptography have the potential to lower costs drastically and to solve many of the issues associated with mobile financial services.

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Henning Kehr holds a professorship at the University of Applied Sciences Worms in the degree program International Business and Foreign Trade. Since 2013, he has been Vice President for Research at the university. His own research activities focused on foreign trade consulting and transaction banking. After his economics studies, he worked in the banking sector for several years.

Graham Tonkin with experience in over 20 African countries, Graham Tonkin has held a variety of roles focused on helping to grow and finance small businesses, encouraging entrepreneurial development. Through his experience, he sees the potential of mobile financial services to mitigate the cost and risk associated with physical cash and increase the quality of life for the two billion unbanked. Graham is now working at a Switzerland based software startup leveraging the bitcoin blockchain and advanced cryptography to create a new transaction platform that connects anyone to global finance with nothing more than a smartphone.

Reiner Bihler joined SAP in 2006. He served at large banking transformation programs with national and international acting retail and corporate banks in varying roles, e.g., business transformation, solution architecture and program management. As Global Head of BTS Financial Service Industry within SAP, he is responsible for large business- and IT transformation programs with SAP's strategic customers in the financial service industry. Before he started his career as an IT consultant, he worked for 5 years for a global acting bank as an auditor.

Digital Supply Chain Management Agenda for the Automotive Supplier Industry

Poorya Farahani, Christoph Meier, and Jörg Wilke

Abstract New digital technologies are on their way to disrupt nearly all areas of what we call 'traditional business processes'. Supply chain management (SCM) as a key business priority of almost every manufacturing company finds itself in the center of this upcoming digital era, where almost everything will be connected to almost everything via the internet. As the world gets connected, in the same way it also gets smarter—thanks to sensors, robotics, 3D printing and artificial intelligence. But how are supply chain executives coping with those new opportunities coming with new technologies? A recent survey identifies, that they are not equipped properly to design a digital strategy for their supply chains, necessarily transforming them into demand-sensitive networks. This chapter will provide a proper recipe for automotive supply chain managers on how to bring new technological innovations on a cohesive agenda. 17 digital SCM use cases, being identified within expert interviews, form the basis for the creation of the digital supply chain management agenda. The use cases will be assessed in terms of value and applicability and therefore be positioned into a value-maturity-portfolio, before being translated into the digital agenda.

1 Introduction

Corporate businesses of all industries, and their supply chains, are witnessing an unmatched era of true business innovation. Breakthrough technologies have matured and hit scale together, enabling five defining trends, namely: hyper connectivity, supercomputing, cloud computing, smarter world, and cyber security (see chapter: The Business Consequences of a Digitally Transformed Economy).

A recent survey of leading manufacturers from different industry sectors revealed that, despite significant focus on innovation as an important strategic pillar, most global supply chains are still not equipped to cope with the aforementioned changes in their business (Farahani et al. 2015a, b). In the new business era,

P. Farahani • C. Meier (✉) • J. Wilke
SAP Business Transformation Services (BTS)—Supply Chain Management Practice, SAP Deutschland SE & Co. KG, Walldorf, Germany
e-mail: poorya.farahani@sap.com; christoph.meier@sap.com; j.wilke@sap.com

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speed is crucial, since product lifecycles are becoming shorter and more fluid. Customers demand quicker development and delivery of new products and services, which translates into the need for improved response times, changing organizational structures, and changing business processes for companies. A key part of this transition includes the transformation of traditional supply chains into demand-sensitive networks (Economist 2014). New technologies allow companies to get a better understanding of customer preferences, and they help companies improve their relationships with their customers.

To get to a leading position—or to maintain their existing position—supply chain managers need to shift their attention from cutting costs to enabling new processes, and making corporations more connected and agile to create value out of these new technological enablers.

For the last few years, digitization of supply chain processes has been presented as the main answer to perennial supply chain worries. However, creation of a practical roadmap towards a target level of digitization is still a complex topic. This chapter clarifies this topic for the automotive supplier industry, by answering an urgent question of many supply chain executives: How do we make use of new technological innovations and how do we bring them into a cohesive agenda and roadmap? To answer this question, we arranged the rest of this chapter as follows:

- Section 2 presents the challenges and trends in the automotive supplier industry based on our recent survey.
- The scope of digitization in supply chain management (SCM) is described in detail in Sect. 3. The core of the digital SCM discussion is clearly the application of emerging technologies to corporate SCM tasks.
- Section 4 outlines 17 digital SCM use cases which were discussed and assessed by SCM executives of well-known global automotive suppliers.
- The view of the SCM experts on value and also applicability of use cases is the basis for the creation of the digital supply chain management agenda in Sect. 5 (including a digital SCM use case portfolio and an exemplary roadmap over the next 5 years).
- At the end, Sect. 6 offers a six-step recipe to develop your own digital supply chain management agenda.

2 Supply Chain Challenges and Trends in the Automotive Supplier Industry

Based on interviews with leading global automotive suppliers, the following challenges, trends, and goals are identified for a time period up to 2020 (Farahani et al. 2015a, b):

- Globalization and sales growth: To respond to the trend of going global, automotive manufacturers (and their suppliers) extend their supply chain management into multi-tier SCM, to source and sell components and parts worldwide.

- Supply chain visibility: With the globalization and the decentralization of supply chains, a key concern that many companies are faced with, especially in automotive industry, is the visibility of not only material, components, and finished products but also processes, resources, and capabilities along the extended network.
- Process standardization and automation: Leading automotive suppliers focus on standardizing and automating processes, to eliminate issues that stem from an increasing number of local and inefficient processes.
- Supply chain collaboration: To stay competitive, supply chain entities must collaborate with all kinds of partners like customers, suppliers, logistics service providers, or even competitors to create win–win opportunities.
- Flexibility in responding to the volatile markets: In the automotive supplier sector, the increasing number of product variants and options adds to the complexity of this market.
- Innovation and new business models: Information technology and private life are merging. In particular, automotive suppliers are being challenged to integrate the functionalities and devices that people are using in their daily lives.

3 Digital Supply Chain Management

For almost two decades, supply chain management has been on the top management's agenda of many industrial companies as a holistic approach to gain a competitive advantage by improving efficiency in the value chain. In that context,

> "Supply Chain Management involves various approaches utilized to effectively integrate suppliers, manufacturers, and distributors in performing the functions of procurement of materials, transformation of these materials into intermediate and finished products, and distribution of these products to customers in the right quantities, to the right locations, and at the right time to meet the required service level with minimal cost. Supply chain management also involves managing a connected series of activities that is concerned with planning, coordinating, and controlling movement of materials, parts, and finished goods from the supplier to the customer. For this to occur, material, financial, and information flows are managed as decisions are made at strategic, tactical, and operational levels throughout the supply chain" (Chandra and Grabis 2007, p. 20).

The fundamental challenges of managing supply chains have been the subject of research since the late fifties. Particularly, the work of Jay Forrester and other scientists, who analyzed the dynamic behavior along multi-echelon supply chains ('bullwhip effect'), built a framework for SCM which is still valid in today's global economy with its complex worldwide logistics networks, long lead times, and high planning uncertainty. The breakthrough of SCM as a new management discipline, however, was much later in the 1990s as a direct outcome of the emerging e-business era and new IT capabilities. Vendors like i2 Technologies, Manugistics, and—later—SAP, developed a new generation of SCM software, so-called Advanced Planning Systems (APS), to address inefficiencies in operations caused by sequential and disconnected steps in production planning. By storing all relevant constraints in a single database and applying operations research techniques like linear programming and constraint solving, optimization of production planning became possible, leading to improved planning results and increased flexibility because planning cycle times could be shortened significantly.

Limitations of APS and other SCM solutions of the 'first wave' became obvious when practitioners explored these solutions beyond their companies' boundaries: in a cross-company context, the detailed data necessary for central optimization is normally not available, due to the local goals and decentralized planning domains of the involved suppliers and customers. This particularly affects the automotive industry, where a large number of independent partners form complex and distributed multi-echelon global supply networks. Accordingly, a 'second wave' of SCM emerged, which was built on collaboration principles and advanced coordination mechanisms like strategic flexibility management and supply contract design. For this extended supply chain management, technology was still important but aspects of organization, collaboration management, and process design became more relevant. Figure 1 shows a typical structure of a supply network where a subset ('supply chain') is selected as the subject for the application of collaboration and coordination principles.

Now, 20 years after the first wave, a third generation of supply chain management is about to emerge: SCM in the digitalized economy. Over the last couple of years, tremendous technology shifts and innovations have developed that are about to change how you do business, including changes to many aspects of our daily transactions as consumers, customers, suppliers, and manufacturers. This fast developing digital economy will, of course, fundamentally affect supply chain design and processes.

There is no formal definition of a digital supply chain management. However, Hoberg et al. (2015, p. 6) defines the wider area of digital transformation, which "can be understood as an organizational change process where digital technologies (such as big data analytics, sensor networks, cloud services) are used to radically change [. . .] how a company creates value [. . .], how it interacts with its customers and business partners [. . .], and how it competes in established and emerging markets." We take this as a basis to define digital supply chain management as leveraging innovative digital technologies to change the traditional way of (1) performing supply chain planning and execution tasks, (2) interacting with all kinds of supply chain participants, and (3) enabling new corporate business models. Developing a mature digital SCM level also requires an organizational change process that reaches every corner of the internal and external supply network. The foundation for every digital SCM strategy is an appropriate agenda.

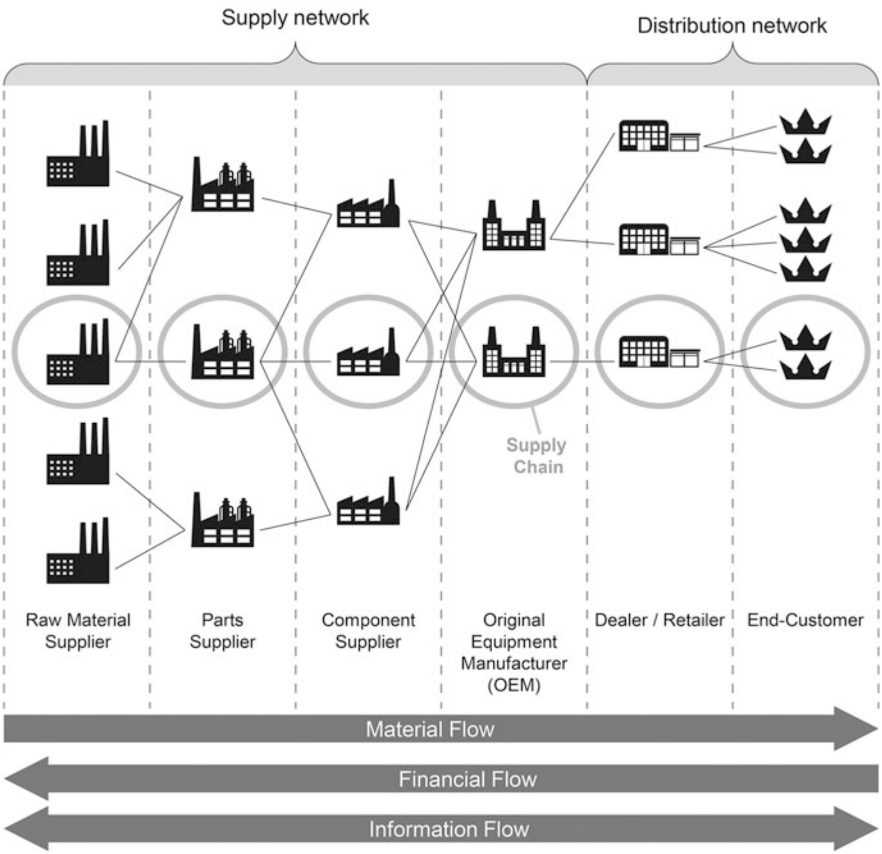


Fig. 1 Simplified structure of a supply network in the automotive industry

3.1 Dimensions of a Digital Supply Chain Management

This section introduces six dimensions of supply chain management according to Porter's (1998, p. 36) well-established value chain model (see Fig. 2). Later, we'll show digital SCM use cases and how they map to these six dimensions.

Transferred from Porter's value chain idea, every supply chain is a number of activities which are performed to supply (raw) material, produce products out of these materials, eventually store the products, and finally deliver them to customers. Therefore, SCM as a discipline can be divided into four primary (customer, logistics and inventory, production, and supplier) and two secondary dimensions (IT and technology and performance measurement).

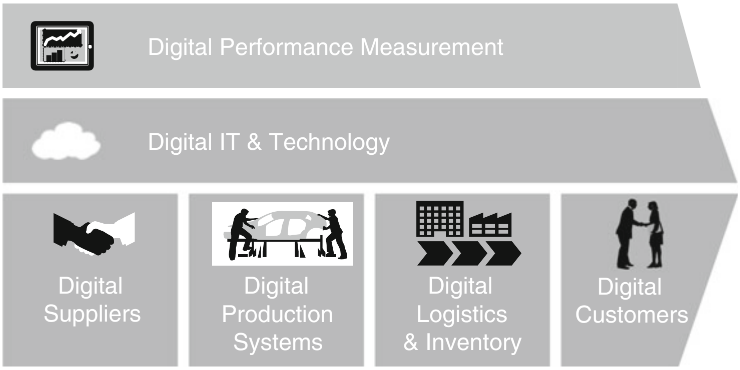


Fig. 2 Six dimensions of a digital supply chain management

3.2 Technological Innovations Relevant for Supply Chain Management

Emerging technologies are new technologies that are currently developing or will be developed over the next 5–10 years, which will substantially alter the business and social environment (Business Dictionary n.d.). The Hype Cycle for Emerging Technologies report by Gartner (2014) is a reference point for the evolution of emerging technologies. It is the longest running annual Hype Cycle, providing a cross-industry perspective on the upcoming technologies and trends. Figure 3 shows the selected key technological advancements that will impact SCM practices the most, according to the Gartner's Hype Cycle.

4 Digital Supply Chain Management Use Cases

To help define a digital SCM agenda, certain use cases demonstrate the concrete application of innovative technologies that highly impact the current and future state of supply chain processes. The following use cases were collected and developed within an innovation study of the SAP® Business Transformation Services SCM team in association with the SAP Digital Thought Leadership & Enablement. The use cases were discussed in expert interviews with high-level SCM executives from five different industries (automotive manufacturers, automotive suppliers, industrial machinery and components, high tech, and consumer products), SC analysts, and well-known SC bloggers. The corporate representatives shared their insights regarding the value of the use cases for their own company and they also shared what stage they were at in applying use cases within the company (for example, use case already applied and rolled out, use case tested within pilot project, pilot project planned, not on the agenda, and so on). Initial findings were published in Meier (2014) and Farahani et al. (2015a, b).

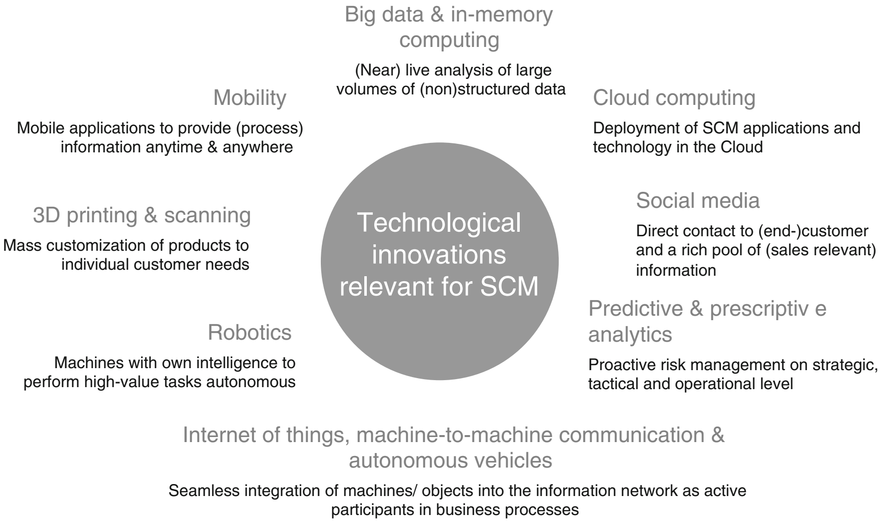


Fig. 3 Technological innovations relevant for supply chain management

Figure 4 shows an overview of the industry-related use cases and their corresponding SCM dimension. In the following sub-sections, the use cases will be outlined in detail.

4.1 Digital Customers

The analysis of company's selling patterns and customer's buying behavior promises insights into our own behavior (How do we sell?) and also the customer's behavior (How do they order?) when it comes to product sales. These insights can be taken one step further by using those analysis results on the product level to determine potential options and option bundling. Among automotive suppliers, it can be difficult to get access to up-to-date customer sales data, especially considering that the main customers are automotive manufacturers (OEMs). Moreover, the sales data often arrives with an approximated time lag of 2–4 weeks. However, for the spare parts business, in which relating with the customer is of primary importance, the use cases gained attention within the automotive supplier industry.

Predicting trends and future behaviors of customers (trend mining) has always been a challenging topic, but with new big data technologies and methods as well as predictive and prescriptive analytics, the detection of new trends can be facilitated and companies can react more quickly to new developments. To make forecasts (in any direction) as accurate as possible, large amounts of data are needed, for example, about what customers bought, or what does the end-product of the future look like—because automotive suppliers 'only' supply parts or modules for an

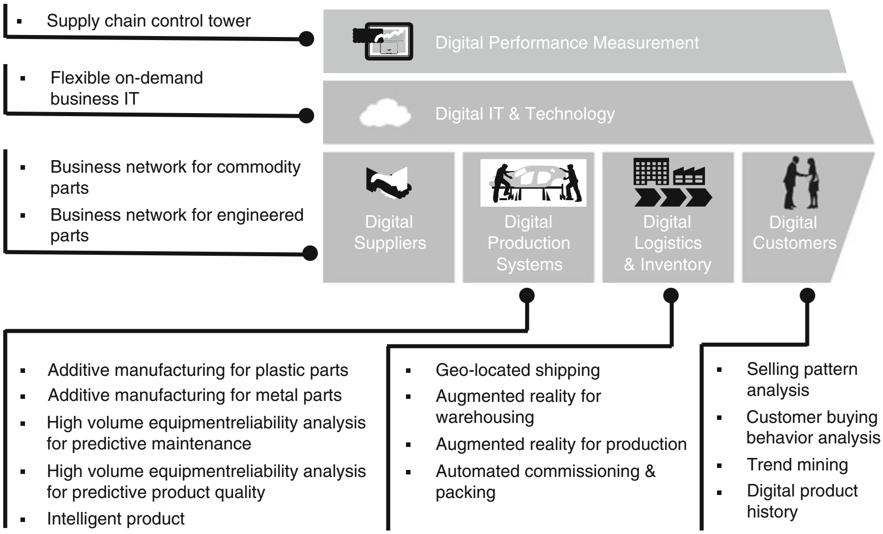


Fig. 4 Digital supply chain management use cases for the automotive supplier industry

end-product (the car). Most of the related data is available in an unstructured way (for example, on Facebook, in Twitter tweets or re-tweets, or in YouTube channels). Thus, trend mining algorithms are needed in order to perform such an analysis. Trend mining programs can filter huge amounts of data coming from different sources (for example, internal data versus market data and social sentiments) and in different formats (for example, written, audio, video). The programs deduce future scenarios by analyzing the filtered data and recognizing available patterns, which are difficult to observe on the initial raw data. Among automotive suppliers, trend mining has already picked up pace. Some leading suppliers have formed joint initiatives with companies that are active in the field of data gathering and analysis on social media. Besides sales analysis, automotive suppliers also show strong interests in applying innovative trend mining ideas in product quality control area.

Discussing the use case of a digital product history, its application can be considered as one of the major parts of a corporate Internet of Things (IoT) scenario. Every product (or component, module, packaging unit, and so on) gets its own identity and history which can be retrieved through RFID, barcodes, or integrated SIM-cards. Every detail of a product's entire lifecycle will be recorded (for example: product characteristics (including modifications); manufacturing history (including operational or machine data); and also repair and maintenance data). In addition, all of this information can be made available for customers, suppliers, distributors, service providers, and production and development departments. For automotive suppliers, the benefits of a digital product history depend on the value and the complexity of the product itself (this business case is more attractive for expensive or critical products). Moreover, companies take different approaches to data privacy—some companies do not have any issue with passing on data to further participants in the supply chain, whereas others do not want to share much information about product history and would rather keep relevant data in-house. In the end, it is a question of what the customer demands, though there is a clear trend towards electronic data required from part manufacturers to understand the product's history, which contributes to an increased safety of the product and stability in the supply chain.

4.2 Digital Logistics and Inventory

Today, products are often shipped around the globe with delivery times of weeks and sometimes even months. To know where the products are at any time, they must be visible and transparent within the supply chain and therefore geo-located. Permanently tracking the location of a physical object and sending out this information to a central data hub can be performed by different technologies known from the IoT. One potential scenario is to use RFID chips with GPS fixed to the product itself or to the transportation unit (for example, container). Regardless of how it is collected, big amounts of data must be captured, stored, and analyzed to enable predictions and simulations in terms of arrival, and this data may need to be connected with weather or traffic forecasts or the telematics of the transportation vehicle. If a logistics service provider is used, the data should be made available by this provider in real time (for example, as a milestone-based, dynamically estimated time of arrival (ETA)—where the ETA is updated along the delivery path passing the defined milestones, or as a predictive ETA based on the past patterns of delivery). Automotive suppliers would be interested in a point-based tracking concept rather than a real-time one, especially because accurate delivery is the responsibility of the shipper. Also this use case is more viable on higher level of transportation units, for example, when applied to containers or ships, because the cost of this technology is still rather expensive. However, the use case turned out to be very relevant for performing emergency deliveries where real-time information about the shipment is vital.

To respond quickly to volatile demand markets, it is important to improve flexibility by modularizing logistics processes, and reduce human interventions and errors by automating processes. Deployment of robots, especially for an automated commissioning, can enable an agile logistics system by reducing wastes, increasing repeatability, and improving throughputs. This use case is considered very attractive among automotive suppliers, especially, for the spare parts business.

Augmented reality enabled by wearable computers could improve employee and company performance and transform work by delivering real-time information to workers, for instance, about stock-on-shelf, tasks to be performed (for example, pick article X), handling conditions, and so on. For picking and commissioning and production purposes, it is very useful for workers to get the necessary information in real-time while they are in motion (or busy with certain assembly tasks) with as little physical contact intervention as possible. In the automotive supplier sector, the idea has already attracted the attention of the leading companies. Pilot projects are in place to reduce processing time and failures. Wearable technologies could be fully integrated into logistics and manufacturing processes in a couple of years. Main concerns are currently related to the ergonomic aspects of the wearable products, especially when they should be used for several hours constantly.

4.3 Digital Production Systems

Additive manufacturing, and the 3D printing technology behind it, is considered a very important innovation by several industries. 3D printing enables production of parts that cannot be produced with conventional production techniques. One of the clear benefits of 3D printing is that parts can be produced wherever a 3D printer can be positioned, thus decentralizing the production. Moreover, this technology has the potential to reduce manufacturing costs for certain products. Generally, the automotive suppliers perceived 3D printing, from today's perspective, to be very useful for the production of spare parts with low volumes and if they are made of plastics. Nonetheless, the quality of the 3D-printed components remains a major concern. Some leading automotive suppliers already use this technological innovation for pilot products and are interested in deploying the use case for spare parts, especially in faraway markets or for old components where it is not economically viable to keep and maintain old machines to produce those low-demand spare parts. However, the technology of 3D printing needs further enhancements to eliminate existing quality concerns, especially when it comes to printing of metal components.

The amount of data generated and available for analysis in the production area of automotive suppliers is enormous; however, tools for effectively analyzing and using such large volumes of data have only come up recently. The use case of a high volume equipment reliability analysis helps companies gain insights and acquire knowledge from big data by using a large amount of machine sensor data. Based on the equipment performance and its characteristics that are provided by sensors, an ad-hoc analysis of data can be carried out in real-time to predict machine failures or to trigger alerts. When failure, potential failure, or other critical issues are detected in the ad-hoc analysis, alerts will be sent to the operators, the owners, and the local dealers, thus improving reaction time. The overall goal of such a use case is to reduce the machine downtime and therefore, the production breakdown costs by understanding machine behavior, reacting in advance, and preventing breakdowns. Automotive suppliers pay significant attention to this use case and have pilot projects for predictive maintenance, which seek to improve the overall equipment efficiency (OEE), reduce downtime, and increase responsiveness. Improved automation of maintenance operations can generate significant benefits, given that the cost of such a use case allows its deployment on a global scale (including in low-cost countries). Once the machine sensor data is available for analytics, automotive suppliers see another application—those of a predictive product quality. If certain machine or process KPIs (for example, vibration or drilling tolerance) are on their way to leave a defined value corridor, predictions on the overall product quality can help to make sure to make the right decisions at the right time and to avoid producing scrap or later making callbacks necessary.

Intelligent products have unique identities and store their characteristics over the entire lifecycle, for example, on a cloud-based platform. Product information can be retrieved via identification through barcodes or RFIDs to help steer production processes and machines, or to implement a digital service booklet. Unlike the use case of a digital product history (see Sect. 4.1), companies can benefit from intelligent products to automate processes such as production, logistics, product return, and failure analysis. Automotive suppliers are already advanced in leveraging such intelligent products and running projects in this direction. As an easier and less expensive alternative, the intelligence is put on the process level instead of the product level, which most of the automotive suppliers consider to be the more valuable option to decentralize the production control process, especially as factory layouts and production processes become more complex and the output requirements (for example, high responsiveness regarding late order changes) become tougher.

4.4 Digital Supplier

The concept of 'business networks', known from the private sector from companies like eBay or Alibaba, helps overcome the complexity of supply chains and provides a platform that functions as a single point of interaction. Supply chain complexity has increased as supply chains have been extended overseas. Challenges of a far-flung supply chain can be characterized by the increased number of business partners, the difficulty of tracking products, a lack of transportation infrastructure, and logistics data overseas, and the increased time for products to get to the end users. Business networks can help overcome these challenges, allowing companies to connect with suppliers, customers, partners, and service providers. The network can work as a single point of contact when it comes to data interchange (sales orders, purchase orders, process data, geo-location data, and so on) and thus, enable a real-time business within a complex network of interlinked supply chains by automating especially purchasing processes. Depending on the purpose of the business network, additional functions can be provided, such as search functionality (for example, for suppliers, parts, services), performance of requests for proposals (RFP), performance of e-auctions, supplier qualification and assessment, and contract and catalogue management. In the automotive supplier industry, the idea of having a business network especially for commodity products is not new. However, adding the complete range of procurement and communication transactions to this network for all suppliers is not practiced yet and is therefore an interesting business case. When it comes to enabling such a business network not only for commodity but also for engineered parts and components, the maturity is much lower. Nonetheless, automotive suppliers stated a clear need and additional value of applying the business network idea also to engineered products.

4.5 Digital IT and Technology

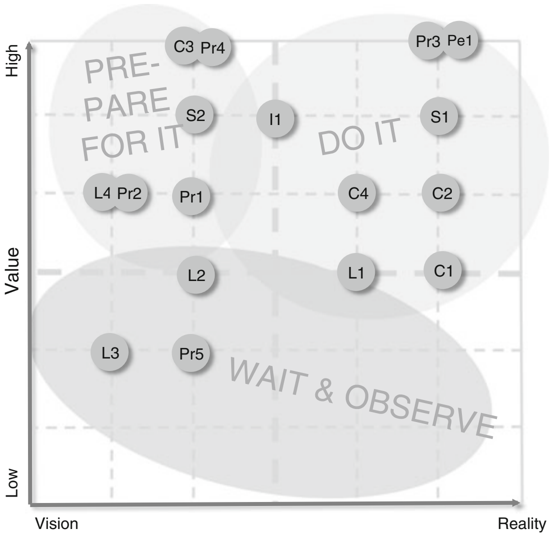
Today, companies can already get most of their demanded business IT as a service, on-demand, and pay-per-use. This kind of flexible on-demand business IT allows companies to move their focus from building and managing large IT infrastructures back to running and optimizing their supply chains. Cloud computing, the technology behind this scenario, will transform supply chain management and have a major impact on the performance of supply chains in the near future. The idea of moving towards an on-demand business IT is a general trend among all industry sectors. In the automotive suppliers section, leading companies consider bringing parts of their IT system onto private/corporate clouds to centralize their IT management and handling, and reduce their need for infrastructure investments. However, there are still common concerns among IT staff about whether the on-demand infrastructure can fully and reliably support the key business processes. To reduce potential risks, companies expect that the private/corporate cloud will be used in the long-term future for their mission-critical and core processes, but the supporting processes can sufficiently be handled on a public cloud. The common consensus is that in the near future, cloud will include a larger proportion of IT within supply chain management especially for the supporting and non-critical systems. However, the execution systems (systems of record) will not move into the Cloud within the next 3–5 years.

4.6 Digital Performance Measurement

Today, companies are looking for better ways to control the end-to-end supply chain and, even more important, having all decision-relevant information easily available on a central tool or device, to oversee all areas of the entire supply network—the use case of a supply chain (SC) control tower. Being able to identify and respond to all kinds of changes to all areas of all corporate supply chains in a timely fashion can be the difference between pulling ahead of the competition or falling behind. Access to relevant data from different areas of the supply chain allows the relevant parties to collaborate and make timely decisions based on updated information. Also, such an SC control tower should enable a central view on the performance of the supply network [single source of truth for all SC-oriented KPIs (for example, overall service level)]. Furthermore, the KPIs should be able to be drilled down to any level of interest (for example, service level per product) and root-cause analysis for out-of-range KPIs should enable insights into real reasons for performance problems and not just symptoms. Finally, decision support by what-if analysis and simulation, and monetary assessment of alternative business decisions complete the wide range of the SC control tower idea. There is a common belief not only in the automotive supplier industry that a performance measurement system around the end-to-end supply chains (and their interlinkage within a supply network) is a key asset as well as a requirement to bring SC transparency and visibility to the necessary competitive level.

5 Digital Supply Chain Management Agenda

In this section, a digital use case portfolio (see Fig. 5) is created from the interview results, and then the use cases are allocated to an agenda. The portfolio method is very useful to sort and prioritize use cases along two dimensions of ‘value-add’ and ‘application maturity’. In the last section, 17 digital SCM use cases were discussed regarding their value-add and their application maturity, both on the basis of expert interviews with SCM executives. If you do the portfolio exercise for your own company, the specific value-add of a use case should be directly derived from and related to the corporate supply chain strategy and eventually further strategies, for example, regarding innovation. Also, the view on an application maturity might be highly corporate-specific and can be created out of analyst reports, pilot projects or prototypes, discussions, and further experiences of the company with the specific technology. For the sake of the exercise, the views and opinions of the interviewed corporate experts are allocated certain values [from 1 (low) to 6 (high)] to the two dimensions ‘value-add’ and ‘application maturity’ for each use case.



Digital SCM use cases

C1 Selling pattern analysis for spare parts (3; 5)
C2 Customer buying behavior analysis regarding spare parts (4; 5)

C3 Trendmining (6; 2)
C4 Digital product history (4; 4)

L1 Point-based geo-located shipping (3; 4)
L2 Automated commissioning & packing for spare parts (3; 2)
L3 Augmented reality for warehousing (2; 1)
L4 Augmented reality for production (4; 1)

Pr1 Additive manufacturing for plastic spare parts (4; 2)
Pr2 Additive manufacturing for metal spare parts (4; 1)
Pr3 High volume equipment reliability analysis for predictive maintenance (6; 5)
Pr4 High volume equipment reliability analysis for predictive product quality (6; 2)
Pr5 Intelligent product (2; 2)

S1 Business network for commodity parts (5; 5)
S2 Business network for engineered parts (5; 2)

I1 Flexible on-demand business IT (5; 3)

Pe1 Supply chain control tower (6; 5)

Fig. 5 Digital supply chain management use case portfolio for automotive suppliers

Depending on the position of each use case within the portfolio, different groups of use cases can be outlined. These groups can be translated into action areas describing how to deal with the dedicated use cases. For example, use cases with a high value-add and also a high application maturity should be done now, whereas use cases with lower maturity might be prepared for (for example, by starting a pilot project or testing the technology within a limited product group or a certain location). Use cases which bring low value (today) might be observed (for example, Google Glass) and checked on a regular basis, if the value-add might have improved. The results shown in Fig. 5 are based on a certain set of interviews, meaning it should not be taken as representative for the whole industry of automotive suppliers. Also there are specific inter-relations between the use cases, which were not considered within the portfolio creation.

Having created the portfolio and grouped the discussed use cases into action areas, one can now derive the digital SCM agenda by allocating the use cases on the time bar. Figure 6 shows an example of a digital SCM agenda, where the specific agenda for one company might look different due to certain company circumstances.

Nonetheless, allocating items from a portfolio into an agenda contains the mandatory exercises of performing (1) a fit-gap analysis (Can we do it (now)?), (2) a rough-cut capacity analysis (Who can do it?), and (3) a duration estimation (How long does it takes us?). Based on the outcome of question #1, one has to decide if there are preparation tasks that need to be completed before starting to implement the concrete use case (for example, data cleansing). This defines the starting point of the project. Exercise #2 should include a skill and resources availability check within the firm to decide which projects can run in parallel and which projects have to be postponed. Finally, each project duration estimation completes the relevant information necessary for an agenda creation.

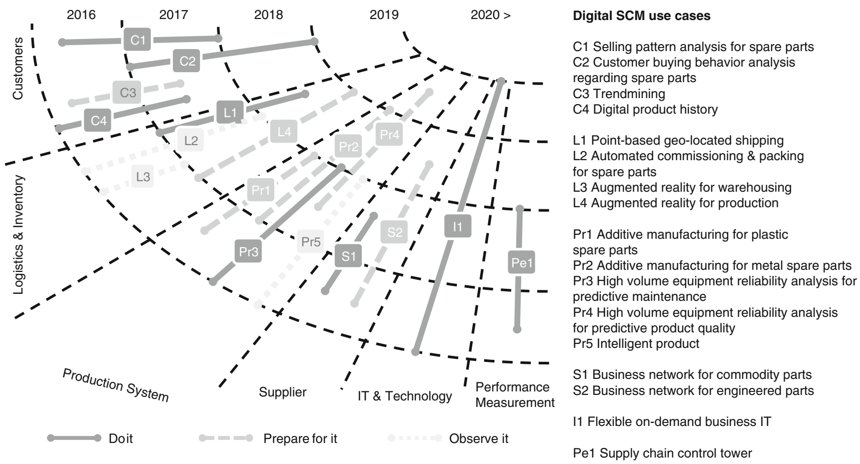


Fig. 6 Digital supply chain management agenda for an exemplary automotive supplier

Having created the agenda, one can start implementing the digital supply chain management. But, because technology advancements will constantly change, the process or cycle of agenda validation and rework should be performed on a regular basis (for example, every 6 months or once a year). Starting a discussion, a pilot, or an implementation of a new technology at the right time is crucial for a future successful supply chain management.

6 Conclusion and Key Learnings

Leveraging emerging technologies—now it is the time to digitize supply chain management practices. In that context, practical roadmaps or agendas towards a target level of digitization are necessary. Often triggered by corporate digital strategies, supply chain executives need to find answers on how to make use of new technological innovations and how to bring them into a cohesive agenda to drive the digitization within the corporate supply chain management strategically. To answer those questions this chapter presents a methodology, which can be seen as a recipe for the development of a digital supply chain management agenda:

- Define what part of SCM is in scope (for example, logistics or production).
- Identify the technological innovations relevant to your SCM scope.
- Match the scoped SCM tasks with the technological innovations and collect or develop concrete use cases.
- Assess the use cases regarding value-add and application maturity.
- Create the portfolio, group and prioritize the use cases.
- Create the agenda and put it into action.

Repeat the cycle on a regular basis (for example, every 6 months).

Key Learnings

- Supply chain management as a key business priority of almost every manufacturing company finds itself in the center of this upcoming digital era, where almost everything will be connected to almost everything via the internet.
- Supply Chain Managers have to find answers on the question on how to make use of new technological innovations and how to bring them on a cohesive agenda and roadmap.
- A digital SCM agenda can be developed in six steps by creating digital SCM use cases, assessing them, prioritizing them and arranging them on a roadmap.

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Poorya Farahani has more than 8 years of consulting and academic experience in the fields of analysis, modeling, and optimization of supply chain strategies and processes. Prior to joining SAP, he worked as a senior researcher at the production management group of the Technical University of Munich, leading several academic and consulting projects in the field of supply chain modeling and optimization. He holds a Ph.D. in Operations Management from the Technical University of Denmark and a Master of Science in Industrial Engineering from the Polytechnic University of Tehran (Iran).

Christoph Meier supports global SAP customers in transforming their supply chains into digital businesses leveraging emerging technologies. Prior to his role at SAP, Christoph was a consultant at FIR Institute for Operations Management heading the IT and Operations practice. He holds a Ph.D. in Industrial Engineering from RWTH Aachen University (Germany) and a Diploma in Industrial Engineering and Management from the Ilmenau University of Technology (Germany).

Jörg Wilke has more than 15 years of consulting experience with focus on operations strategy and supply chain management, in particular in the automotive industry. Prior to joining SAP, he worked as a manager and consultant at different management consulting companies and for 6 years at Daimler AG in the central business division of Manufacturing and Supply Nets. Jörg holds a Ph.D. in Business Administration and a Diploma in Industrial Engineering and Management from the University of Paderborn (Germany).

Value of Lifecycle Information to Transform the Manufacturing Industry

Gerhard Gudergan, Achim Buschmeyer, Boris Alexander Feige, Denis Krechting, Stefan Bradenbrink, and Ralph Mutschler

Abstract Two major trends are driving many companies in the manufacturing industry to rethink and reconfigure their business logic: the trends towards applying a service dominant business logic, and the trends towards collecting and using information about the market life cycle of products. The pursuit of market lifecycle information has lately been one that is driven mostly by tremendous developments in the area of the Internet of Things and information system integration. Companies in the manufacturing industry are reconfiguring their value chains, tending towards a higher degree of service orientation. This transformation requires an understanding of the principles behind offering additional value through industrial product-service systems. The design of an adequate information architecture and the subsequent management model are the key factors for a successful implementation. This chapter focuses on how information gathering, analysis, and the meaningful use of information have been linked to the success of those companies within the German manufacturing industry which have made the transformation towards service-orientation. On the basis of an empirical study, five success factors with a significant impact on either innovation performance and/or operational performance are identified. These findings are enhanced to derive guidelines for an adequate information architecture. The guidelines are underpinned by best practices of prosperous companies with a strong product-service-orientation. Links between best practice application and performance are analyzed, and significant relations are identified.

G. Gudergan • A. Buschmeyer • B.A. Feige • D. Krechting
Department of Business Transformation, FIR at RWTH Aachen University, Aachen, Germany
e-mail: gerhard.gudergan@fir.rwth-aachen.de; achim.buschmeyer@fir.rwth-aachen.de; boris.feige@fir.rwth-aachen.de; denis.krechting@fir.rwth-aachen.de

S. Bradenbrink
S.Bradenbrink Consulting, Langenargen, Germany
e-mail: stefan.bradenbrink@sbcon.eu

R. Mutschler (✉)
SAP Business Transformation Services (BTS), SAP (Schweiz) AG, Biel, Switzerland
e-mail: ralph.mutschler@sap.com

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1 Introduction

For many industries, the former business model, that focused primarily on material products, is losing ground to customized, tailor-made business-specific services that complement the product (Penttinen and Palmer 2007; Md. Sohel-Uz-Zaman and Anjalin 2011; Roy et al. 2009a). The main reasons for this development lie in an increasing level of competition in mature markets, an increasing orientation towards addressing environmental and sustainability concerns, and maturing technologies that make it difficult to differentiate product offerings from those of competitors (Cedergren et al. 2012). Hence, service is another possibility for manufacturers to achieve additional revenues or a higher market reach. Integrated product-service-offerings can be a means of differentiation and provide a market defense to competition from lower-cost economies, particularly in the manufacturing sectors with an installed product base (Stark 2011). More importantly, a service-driven logic offers the opportunity to innovate towards completely new business models, such as performance-based contracting or output guarantees. As such, business-related services offer the chance to generate a constant revenue stream, instead of the one-time sales-event provided by single-product offerings. This is known as the 'Servitization of manufacturing' and requires a transformation of the entire company (Meier et al. 2010). This trend is particularly observable in Germany where 30 % of the manufacturing firms are considered to be servitized (Neely 2013).

Servitization creates industrial solution systems that integrate industrial services with high-investment industrial goods. The underlying concept falls under the term 'Industrial Product Services Systems' (IPS^2) (Steven et al. 2009). Herein, services are not considered as add-ons to products but instead as an equal part of an integrated product offering over the entire product and service lifecycle. So, production companies increasingly link products, parts, after-sales services and valued-added services (such as training), plus business consulting and engineering services, into an integrated solution system. This can successfully set a company ahead of its competitors. The concept is illustrated in Fig. 1.

The underlying strategy in industrial markets is to substitute single offerings with integrated value added solutions that lead to lasting relationships and that closely link providers to customers. Information and communication technology offer new potential to transfer data from the front-end of the service technician to the early steps of the product development process and vice-versa. This development is enhanced by sensors and actuators becoming intelligent and fully integrated in industrial goods. Numerous types of data on an unprecedented quantitative and qualitative level are transmitted and can be used to gain new insights into customer demand and to derive new products and associated services. To illustrate the process, Fig. 2 shows a framework that supports producing companies to systematically plan the transformation from a product focus towards a service and customer–centric enterprise.

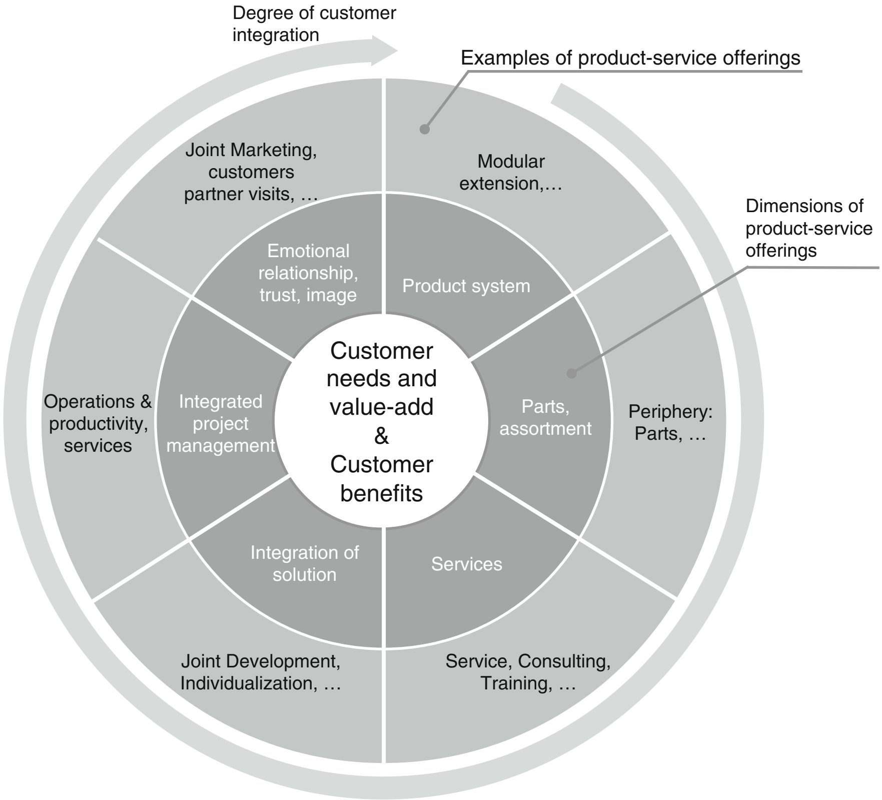

Fig. 1 Solution-systems focusing on customer value [based on (Schuh and Gudergan 2009)]

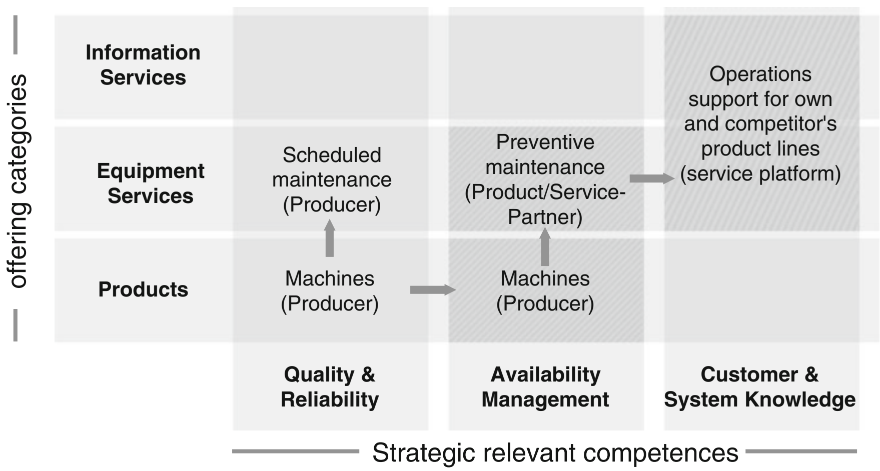

Fig. 2 Patterns for product-to-service-transformation

In the following, a manufacturer of aircraft engines is considered that is transitioning from producing engines to providing fleet optimization platforms. During this transformation, a change happens in the company's strategic relevant competences to occur: from a focus on quality and reliability, to a focus on an availability management, and finally one involving customer integration and system knowledge. The product focus is expanded by acquiring, analyzing, and commercializing data that offers new service potentials, such as preventive maintenance, fleet management, or flight optimization.

The ongoing servitization of the manufacturing industry (Baines et al. 2007), combined with the increase in information exchange between service applications and smart structures, enables new ways to improve the performance of IPS^2. Therefore, it is important to know the success factors that favor efficient information exchange in the IPS^2 lifecycle. Schweitzer and Aurich (2010) explain the need to refine the information exchange process in service networks. In particular, they outline the importance of detailed specification of information regarding the characteristics of Product-Service Systems in the identification, gathering, analysis, and allocation of information. However, there is a gap in research on the design of an adequate information architecture of IPS^2. In an attempt to reduce that gap, this paper focuses on how the information gathering, analysis and the meaningful usage of information is linked to the success of service-oriented companies within the German manufacturing industry. Our goal is to provide the results of this research, specifically with a view on the following distinct questions:

1. What factors in the information exchange of an IPS^2 lifecycle can positively influence the performance of manufacturing companies?
2. What best-practices in information exchange are followed by high performing manufacturing companies with a strong IPS^2 orientation?
3. What are adequate management guidelines of an information architecture for IPS^2?

We start by presenting our theoretical foundations, and we explain the chosen research model and corresponding research design. Then, we present the results of the empirical analysis, provide a list of best-practices, and derive management guidelines on how to design an efficient information architecture as part of creating a successful IPS^2. We conclude our paper with a reflection on the results of our research—and provide a brief outlook on further research topics.[1]

[1]Parts of this paper were first published in Proceedings of the 7th CIRP IPSS Conference (doi:10.1016/j.procir.2015.02.133).

This paper continuous our previous considerations.

2 Background

2.1 Industrial Product-Service Systems

The term ‘Product-Service System’ (PSS) has been under discussion in the scientific community for over a decade. Currently, various definitions exist. Goedkoop et al. (1999) were first to clarify the basic elements of PPS:

> (Goedkoop et al. 1999) Whereas a Product characterizes a tangible commodity that is manufactured to be sold, a Service describes an intangible commodity that is offered to a customer with an economic value, often done on a commercial basis.

The authors define a ‘system’ as a collection of elements that includes its relations. So, within the servitization context, a PSS is defined as “an integrated product and service market proposition that delivers value in use” (Baines et al. 2007 p. 3; Stark 2011). The respective market share in product or service can vary, either in terms of function fulfillment or economic value. The dematerialization of solution offerings is one of the fundamental ideas of a PSS (Stark 2011). To develop a PSS, an approach often used is to take the physical product as a starting point (Morelli 2003). This perspective enlarges the concept of a PSS by adding specific stages to the lifetime of a product, which reflect typical characteristics of the product or service. By explicitly considering individual customer needs, a unique system of tangible and intangible commodities can be offered. The system can impose new barriers to imitation from competitors and consequently ensure a longer-term competitive advantage.

Placing the PPS concept within the industrial context is what brings about the IPS^2 (Steven et al. 2009). Various definitions of IPS^2 have appeared in business literature. Cedergren et al. (2012) have reviewed papers that define IPS^2. The following is their summary of what they consider to be the most important definitions of IPS^2:

- Roy et al. (2009b): IPS^2 is a marketable set of products and services capable of jointly fulfilling a user’s need.
- Zhu et al. (2010): IPS^2 is a solution of optimal resource operations in the product lifecycle through integrating tangible products with intangible services.
- Erkoyuncu et al. (2011) (focusing on a specific case of PSS): IPS^2 means providing services for a product core that has a high net-value and involves transactions in a B2B context.
- Meier et al. (2010): IPS^2 is the integrated and mutually determined planning, development, provision and use of product and service shares including its immanent software components in Business-to-Business applications representing a knowledge-intensive socio-technical system. In another paper by the same authors (Meier et al. 2011), IPS^2 is defined as a concept that forces a new understanding for business relationships within the business-to-business market. The IPS^2 are based upon product-service systems that can be defined as

customer life cycle-oriented combinations of products and services to provide a higher customer value.

- Schuh et al. (2011): IPS^2 is a combination of existing physical products with value adding services. Summing up, the servitization of the industry lead to an integrated offering, consisting of services and the product itself, namely a PSS. Furthermore, it was elucidated that there is no unanimous definition of the term IPS^2.

In summary, the servitization of industry will lead to an integrated offering, consisting of services and the product itself—a PSS. For now, there is not unanimously agreed upon definition of the term IPS^2.

2.2 Product-Service Lifecycle Management

As the name implies, the ‘Product-Service Lifecycle’ concept examines the link between the product lifecycle and the service lifecycle. The product lifecycle ranges, on the one hand, from requirements elicitation, product and manufacturing planning, and product manufacturing (Ehrlenspiel and Meerkamm 2013) on the other. The Service Lifecycle consists of service creation, service engineering, and service operation. Hence, it includes service activities over the whole lifecycle of a product, instead of a succession of selective service activities, and it thereby enhances customer value (Wiesner et al. 2015).

Stark (2011) proposes a classification of five significant phases that a product or service can undergo throughout its lifecycle. The first phase is ‘imagine’: during which the lifecycle begins as an idea in people’s heads. The ‘definition’ phase is when the idea is converted into a detailed description. The ‘realization’ phase is when the product, service, or PS^2, is ready to be used by customers. The ‘use and support’ phase is when the products or services are in full use. The ‘retiring or dispose’ phase is when the product or service is no longer in demand.

Stark (2011) therefore defines product-service lifecycle management as “[. . .] a business activity of managing, in the most effective way, a company’s products and services all the way across their lifecycles; from the first idea for a product all the way through until it’s retired and disposed of.” Figure 3 illustrates the definition and shows the design of a mutually dependent system where experiences from the engineering and manufacturing phases feed the Service Lifecycle, and vice versa. This reciprocal system sets the basis for a continuous improvement of product engineering and service delivery. And it facilitates innovation for new products or services.

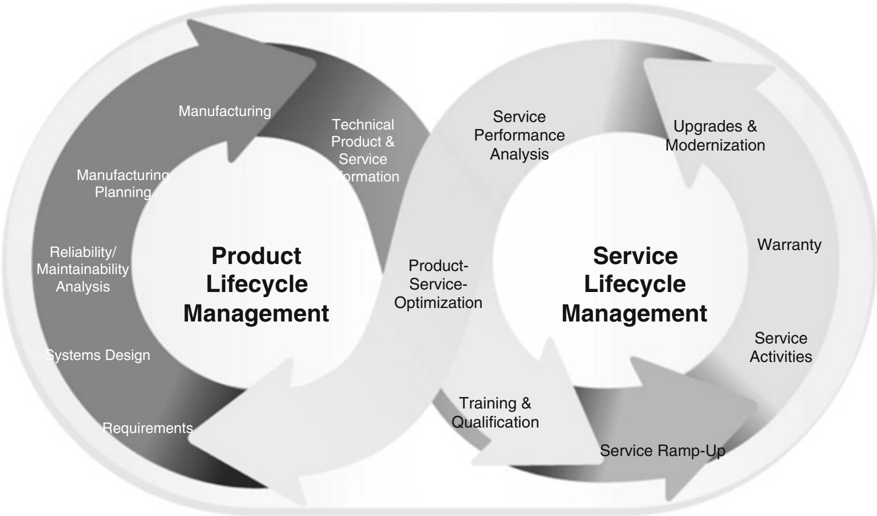

Fig. 3 Product-service lifecycle (Giacomo 2013)

2.3 *Information Linkage and Exchange*

The question is how to optimize the interaction between lifecycle phases and, in particular, optimize how this new information affects the different phases of the product lifecycle. Wiesner et al. (2015) identified four patterns of interaction between the product and the service lifecycle, varying by time dependencies. The first two patterns involve a sequential interaction between the Service Lifecycle Management (SLM) and the Product Lifecycle Management (PLM). The SLM will either be trigged by a phase of the PLM, or the other way around. These two patterns characterize a more separated interaction between both lifecycles. This is contrasted by aligned or integrated patterns, which demonstrate a more intensive interaction between the PLM and SLM. If the integration of Product and Service lifecycles is partial, the interaction between them consists of coordination, exchange of information, negotiation, and problem solving of conflicts. What's important to note in this context is the information exchange between service technicians in field service operations and their colleagues in research and development. A constant exchange of information in both directions ensures feedback from the field is relayed and responded to as part of the product or service creation process (Kastalli and van Looy 2013). The contact that service technicians have with a customer's offer, offers unique ways of gathering information and data. Both sites benefit from that exchange. Figure 4 shows the bidirectional exchange of information gathered in 'Customer', 'Service', and 'Engineering' processes. The specific knowledge about individual customers helps to establish unique service offerings, tailored to individual demands.

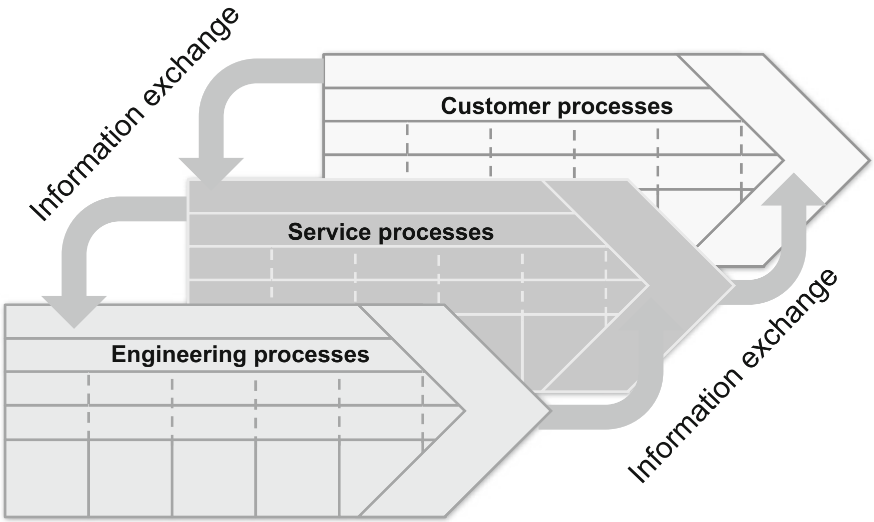

Fig. 4 Information linkage and exchange along the IPS²

2.4 Organizational Ambidexterity

A primary target of a successful PSS is to guarantee a high organizational performance. In this paper, we define organizational performance as "[. . .] the economic outcomes resulting from the interplay among an organization's attributes, actions, and environment" (Combs et al. 2005, p. 261). Organizational performance is based on the concept of 'organizational ambidexterity'. The term was introduced by Duncan (1976) to mean the ability of an organization to simultaneously exploit existing competencies while exploring new business opportunities (O'Reilly and Tushman 2013). In that context, exploitation is associated with activities such as refinement, efficiency, selection, and implementation, whereas exploration refers to "search, variation, experimentation, and discovery" (March 1991, p. 102). The ability to balance efforts between efficiency and innovation is essential to the survival and performance of a company. In mature markets and technologies in particular, control and incremental improvements are indispensable (Levinthal and March 1993). At the same time, organizational ambidexterity allows a company to compete in new technologies and markets where the focus is set on flexibility, autonomy, and experimentation. This paper researches several studies in search of empirical evidence that validates the connection between ambidextrous organizations and various subjective levels of performance—for example, financial or innovation performance (Jansen et al. 2005; Markides and Charitou 2004).

3 Research Model and Approach

We developed a research framework to determine the cause–effect relationship between (1) Information gathering over the product-service lifecycle, (2) data analytics, (3) interpretation and use of new information, and (4) distribution of new product-related information and the impact of these four aspects on performance.

In our research approach, we set exploration and exploitation as a performance axis within the service context. We define performance as the ability of a company to be service-efficient (exploitive perspective) and to develop new innovative business opportunities in the service sector (explorative perspective) at the same time. A high performance level exists when an organization is able to achieve a high efficiency level, which was labeled as 'Service Excellence', combined with the ability to explore new business ideas, labeled as 'Innovation Capability'.

In that context, we adapted a typology, based on the work of Sutcliffe et al. (2004), that segments the matrix of service excellence and innovation capability into five areas. In our approach, we modified the matrix by using four areas, to avoid logical overlapping or misunderstanding in our adapted typology. The four segments characterize specific organizational orientations.

Figure 5 shows the relationship of the four areas. A low efficiency and innovation level is given when an organization moves in a strong 'reactive' manner. Whereas new business opportunities for service offerings are evaluated on the basis of a defensive and follower-oriented strategy, reactive behavior is characterized by an inhibited and reduced organizational will to create and continuously increase customer value. The opposite is determined by a 'dual' organization. Dual organizations are able to manage the balancing act of efficiency and innovation efforts. Characteristics of a dual organization are a constant search for new business opportunities based on received service-information feedback, combined with a strong impetus to reach a high level of service excellence.

Another segment identifies a 'singular adaptive' organization, which is the opposite of a 'singular mechanistic' organization. A singular adaptive service orientation is given when innovation is seen as a key driver for performance but the capability to reach service excellence is not a dominating organizational

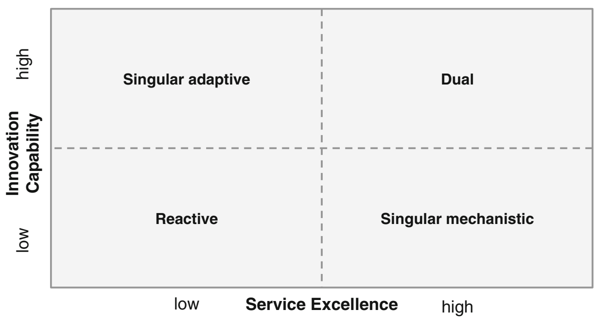

Fig. 5 Efficiency and innovation impact on performance (based on Tushman and Anderson 2004)

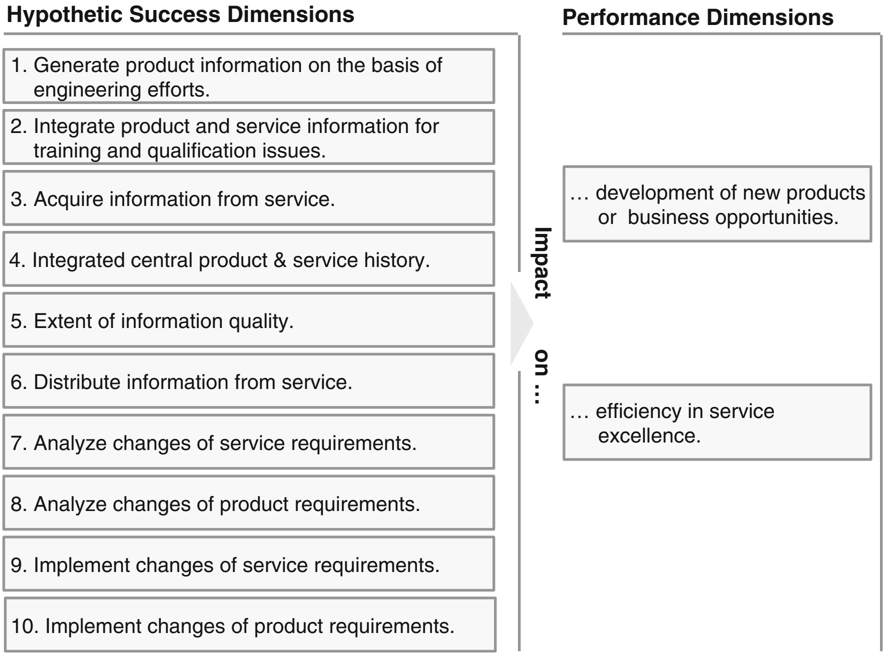

Fig. 6 Research model

characteristic. A singular mechanistic organization reflects the contrary perspective.

On the basis of our typology, we offer ten success dimensions that describe the distinctive characteristics or capabilities of a firm that offers IPS^2 that may lead to a higher performance level. The success dimensions are formulated as hypothetical statements. The research model is shown in Fig. 6.

Service efficiency and innovation capability are positively influenced by the following:

I. The ability to generate product information on the basis of engineering efforts.
II. The integration of product and service information for training and qualification issues.
III. The acquisition of information from service.
IV. An integrated central product and service history.
V. The extent of information quality.
VI. The ability to distribute information from service.
VII. The analysis of changes in service requirements.
VIII. The analysis of changes in product requirements.
IX. The implementation of changes in service requirements.
X. The implementation of changes in product requirements.

(I) The ability to generate product information on the basis of engineering efforts is the foundation for a close interaction between internal engineering and service departments. The integrated interaction between both ends of the value chain helps to create product information that suits individual customer demands and increases knowledge between both groups. (II) The capability to integrate product and service information for training and qualification efforts helps to provide knowledge and insights for both engineers and service technicians. (III) The ability to acquire information from service in a structured way and, in particular, to its full extent is a fundamental competence—it's mandatory for creating an extensive exchange of information between the different lifecycle phases. So, information gathering at the service front-end is the starting point of a successful information loop that fosters service excellence and innovation capabilities. (IV) As a third success factor, we noted the involvement of an integrated central service and product history. A consistent service and product history continuously enlarges the data basis for analytics and helps to reveal possible coherencies and interdependencies. (V) We also suggest that information quality has a strong impact on the success dimensions. A high-intrinsic, contextual, representational, and accessible level of specific information characterizes information of the highest quality (Lee et al. 2002). It guarantees a solid information foundation and allows further decisions and actions. (VI) The ability to distribute information from service means that the service organization can transmit data, given the usage of a suitable infrastructure and equipment, to other relevant entities for further analysis. (VII) The analysis of changes in service and product (VIII) requirements helps organizations to react promptly to upcoming alterations on customer requirements or innovations that are based on technical or market trends. An early analysis of these changes helps to recognize incremental or disruptive drivers that may require an appropriate reaction. (IX) Finally, we suggest that, besides the analysis, it is also essential to implement changes in service and product (X) requirements. The ability to act on required actions, based on analysis, is the final step in reacting to requirement changes in the IPS^2.

We hypothesize that these ten success dimensions lead to a higher performance level of IPS^2 and of the organization itself. We think that these dimensions are the cornerstones of an extensive information exchange between the service front-end and engineers at the early stages of an IPS^2 development. In our research, we analyze the impact that these ten success dimensions have on company performance. In particular, we look at whether an organization can reach a new level of service excellence and develop new product ideas or business opportunities.

4 Empirical Analysis

Based on the given research framework, we conducted a study to prove our hypotheses. The underlying data were gathered by questionnaire. The questionnaires were given to the service departments of various companies within the

German manufacturing industry. The final survey was initially pre-tested to secure clarity of the questions. The questionnaire was structured to collect general information about the organization and its industry orientation, as well as information about specific dimensions of its service business. We were especially interested in the service business model and its underlying success factors. Possible answers were based on four different and disjointed response categories, to enhance the reliability of the underlying multidimensional questionnaire (Mummendey and Grau 2014).

4.1 Survey Results

72 surveys were received, for a response rate of 3.27 %. The job descriptions of respondents varied. 25 % of the surveys were filled out by chief service managers. General Managers, company owners, or shareholders represented 23 % of respondents. 11 % represented group or regional service managers. 41 % held other positions, such as sales engineers, service project-leaders, and business support as well as business development managers. Almost half of the participants had worked for at least 5 years in their stated position, 37 % between 2 and 5 years. The participating companies have a broad range in terms of turnover and number of employees. Most of the sample companies are from the manufacturing industry (74 %), with the automotive industry at 9 %. Other sectors such as the packaging, rail, or energy industries represent 17 %. After Europe and North America, most of the companies are operating in representative service offices in areas of exceptional growth like PR China or India. Regarding labor structure, only 8 % of the surveyed companies employ third-party service personnel.

Most of the companies forecast a high sales growth of service offerings. From service, 33 % predict an annual sales growth rate between 2 and 5 %. 46 % refer to a growth rate higher than 5 %. Most of the companies offer additional services for their own product portfolio (52 %). 37 % have a hybrid approach to services for their own products and external products, while the rest of the respondents are focusing on external products. Most surveyed companies (86 %) focus on a field-based service strategy, where service is conducted via remote infrastructures or directly on customer's sites.

4.2 Statistical Findings

The evaluation follows the development and verification of hypothetical constructs and the use of a linear multiple regression analysis. The applied scales were approved by using an explorative factor analysis. Hypotheses were tested for their influence on performance dimensions, service excellence, and innovation capability by use of a linear regression analysis.

Table 1 Results of linear regression analysis for service excellence

Significant influence on service excellence (efficiency)	Non standardized coefficients		Standardized coefficients		
	Regression coefficient	Standard error	Beta	T	Sigma
(Constant)	1.123E−016	0.103		0.000	1.000
Extent of information quality	0.478	0.106	0.481	4.515	0.000
Product information based on engineering efforts	0.234	0.111	0.234	2.103	0.039
Acquire information from service	−0.236	0.114	−0.236	−2.080	0.041

Three of the ten success factors were shown to have a high impact on achieving service excellence. First, the findings showed that the extent of information quality has a strong significant influence ($\beta = 0.481$, $T = 4.515$, $\sigma = 0.000$) on service efficiency. The same insight could be confirmed for success factor no. 1, the ability to generate product information for service offerings on the basis of engineering efforts ($\beta = 0.234$, $T = 2.103$, $\sigma = 0.039$). The third success factor that has a strong impact on service excellence is the ability to acquire information from service ($\beta = -0.236$, $T = -2.080$, $\sigma = 0.041$). Other hypotheses concerning service excellence could not be confirmed due to low significance. Table 1 shows the statistical results of confirmed positive coherencies.

Examining the impact of the second performance dimension—innovation capability—we were able to confirm three significant success factors. A service organization's capacity to innovate, and thereby create new business opportunities, is impacted by the involvement of an integrated central product and service history ($\beta = 0.263$, $T = 2.271$, $\sigma = 0.026$). The second confirmed factor is the ability to acquire information from service ($\beta = 0.222$, $T = 1.898$, $\sigma = 0.062$). The third element is the ability to integrate product and service information for training and qualification issues ($\beta = 0.211$, $T = 1.947$, $\sigma = 0.056$). Other formerly stated hypotheses related to organizational innovation capability, e.g., analyzing changes in product requirements, could not be confirmed. Table 2 highlights the results.

The results expose one success factor that has a significant impact on service excellence ($\sigma = 0.041$) and innovation capability ($\sigma = 0.062$). The ability to acquire information from service seems to be highly relevant in reaching a high service performance level. The impact of other success factors on service excellence and innovation capability could not be confirmed.

Combining the results of 'efficiency' and of how the innovation impacts performance, the study reveals five insights for the key characteristics of dual, singular mechanistic and singular adaptive organizations. The results prove that a dual organization is not only able to acquire information from service, but also to reach a high quality level. Moreover, the ability to also generate product information on the basis of engineering efforts is a relevant attribute of dual organizations. Another important success factor for dual organizations is their use of acquired data for training and qualification issues. This establishes a comprehensive knowledge

Table 2 Results of linear regression analysis for innovation capability

Significant influence on business opportunities (innovation)	Non standardized coefficients		Standardized coefficients		
	Regression coefficient	Standard error	Beta	T	Sigma
(Constant)	2.049E−016	0.106		0.000	1.000
Integrated central product and service history	0.263	0.116	0.263	2.271	0.026
Acquire information from service	0.222	0.117	0.222	1.898	0.062
Product and service information for training and qualification issues	0.211	0.108	0.211	1.947	0.056

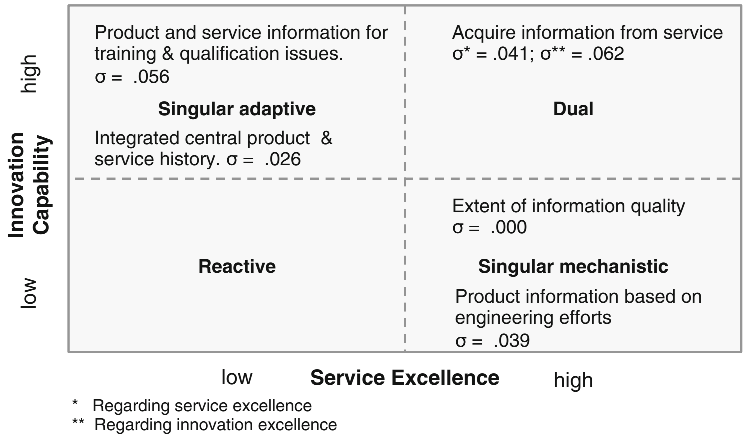

Fig. 7 Study results

base for service technicians and field engineers. Finally, an integrated central product and service history continuously enlarges the data foundation and supports further analytic approaches. The final results are highlighted in Fig. 7.

5 Best Practices and Management Guidelines

Based on the results of the empirical analysis, we defined best practices across the IPS^2 lifecycle. These best practices could help illustrate and confirm the superior results of information exchange as a potential benchmark for practitioners. The following best practices are clustered in categories and refer to the relevant process steps of the product-service lifecycle previously introduced.

5.1 Information Creation for Product and Service Offerings on the Basis of Engineering Efforts

Producing relevant information for product and service offerings in general, and for field service engineers in particular, is a major challenge for many companies. This is often due to having separate bills of materials for product and service applications. It's therefore highly important to link any kind of bill of material, including product and service engineering, to product manufacturing, and field service demands. Linking bills of material over the entire IPS^2 lifecycle guarantees the validity of technical information. Updates or changes in any stage of the IPS^2 lifecycle could have an impact on previous or further stages. Linking ensures that data is consistent, and it establishes an information culture that takes a 'single source of truth' approach.

5.2 Training and Qualification for Service Personnel

Targeting the next stage in the IPS^2 lifecycle, we shall outline the best practices for qualifying and training the service personnel. Nearly all the surveyed successful companies recommended that learning materials be developed by bringing together field service experts as well as product engineering and manufacturing employees. This multi-competence approach helps to identify relevant mandatory information for field service technicians. Besides the initial compilation of the information, regular updates of learning material are necessary to spread field service insights in mature phases of the IPS^2 lifecycle to the entire service department. Another best practice for qualifying and training service personnel is the use of multi-channel tools and methods that complement the learning process by stimulating different learning channels. The application of such tools varies, depending on trainee qualification and specific teaching content. Prominent tools in the group of high performing service companies are intra-organizational wiki-systems, job-rotation, or computer-based learning.

5.3 Service Delivery

Concerning the service delivery process, the companies we questioned tend to establish a central system for acquiring, structuring, and using up-to-date information for field service applications. Therefore, it's highly important to acquire all relevant data that is produced while providing on-site customer service. To acquire relevant information, a standardized information recording process is essential. Relevant information for service activities must be up-to-date, reliable, and comprehensible. Anytime, anywhere accessibility to information for service technicians supports an efficient service delivery process.

Another best practice is the ongoing optimization of spare-part logistics for the customer-specific service history, with respect to the maintenance of individual user profiles and the operation site itself. With these customer-specific data, companies can offer an individual service schedule including maintenance, repair, or overhaul activities.

Summarizing best practices in the service delivery process, the potential lies in activities leading to a higher efficiency level, more precisely in reducing the costs of spare parts, on-site service time, and service assignments.

5.4 Analyzing and Optimizing Service Delivery

Three best practices were found about the analysis and the continuous optimization of the service delivery process. Most of the observed high performing companies establish a central knowledge-database. Such a knowledge-database includes quantitative and qualitative information for standardized and for one-time (or novel) service assignments. The database is accessible for most of the employees involved. To manage such a broad user base, and to ensure an appropriate and target-oriented information flow, a role-based access control is used. Furthermore, insights from field service are taken into account, and inter-divisional information exchange is made mandatory. Those insights are used for product improvements to enlarge serviceability and to improve the product itself. Additionally the simulation of service activities is increasingly used to optimize the disposition of service technicians, and also to improve service task efficiency.

5.5 Management Guidelines for Information Acquisition, Analysis, and Usage

The results raise an important question: how can service or general management transfer the success factors and best practices into their organizations, and strive for service excellence and extensive innovation capabilities? As a starting point for management practitioners, we have developed a set of management guidelines to help establish an intensive information exchange along the IPS^2 lifecycle. The guidelines focus on three relevant fields of action, ‘IT-Systems’, ‘Quality Management’, and ‘Customer Integration’. These domains are key enablers to successfully integrate the best practices and success factors within organizations. The corresponding model is illustrated in Fig. 8.

The stated fields of actions vary from hard facts like IT-systems to soft influencing factors like corporate culture or customer integration. The range reflects the

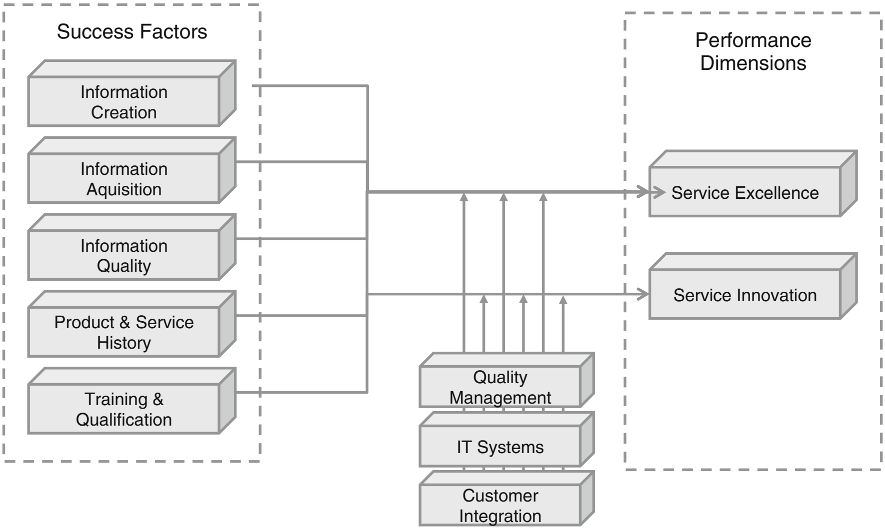

Fig. 8 Management guidelines for service efficiency and service innovation

circumstance that an effective IPS^2-management is a multi-disciplinary approach that goes far beyond a static management framework.

IT-systems are continuously gaining in relevance. They enable organizations to establish an integrated information architecture that goes beyond company boundaries and includes physical assets, value chain partners such as external service subcontractors, tier 1-to-n-suppliers and customers. The emergence of technology trends, like hyper connectivity, supercomputing, cloud computing and smarter world and cyber security drive companies to reevaluate their IT-systems and the ways in which they can transform their IT landscape. IT-systems have to bring flexibility to the company and should focus on simpler IT deployment, more flexibility for business process change and real time connections to people, devices and assets. Therefore investments in IT infrastructures and 'Service-Management-Systems' are of high relevance and are a fundamental component of an integrated IPS^2.

Over the last decades, companies have built large, complex IT landscapes to support traditional business processes. The legacy systems in these landscapes were not designed to support hyper connectivity and the resulting high data and transaction volumes generated by an IPS^2. Building on it will further complicate IT landscapes and inhibit service innovation and agility. The first step to keep up the pace of a quick deployment of IPS^2 is the simplification of the IT landscape to minimize the incompatibility issues between systems. As companies become engaged in the simplification of their IT landscape, they need to leverage current innovation in the field of IT and consider a 2 speed IT strategy, to allow them to rethink their core IT and opportunistically adopt IT innovation. To do so, companies will have to consider deployment options both in the cloud and on premise to better suit their needs for control, flexibility scalability, ubiquity and business agility.

Service Management Systems (SMS) are based on functionalities comprising three elements: core functions, support functions and data management. Core functions include all chronical service activities that are closely related to the operational structure of the service delivery process. Typical subsystems include the processing of enquiries, service task planning, controlling activities and invoicing. The subsystems should be tightly integrated with the ERP and ensure that, on the one side, the core allows the development and support of IPS^2 while, on the other side, supporting the decision making process across the company. Support functions are focusing on administrative tasks, service contract administration or complaint management. The third element, data management refers to gathered data of the IPS^2 lifecycle. Data sources are widespread and heterogeneous by nature. It includes customer related information, such as customer information, with products and services in place at the customer. It is complemented with products and services description data, such as service procedure, product description, specific tools or technician qualification required. With the raise of Internet of Things platform, it can be complemented with real time operating data from the products. The last type of information relates to the service delivery on the physical system and can be service technicians' availability, localization; specific tools and spare parts localization and availability. The information related to the product includes, spare parts' availability localization and real time data coming through an IoT platform. Acquiring all these kinds of different data categories helps to establish an IT-system that is able to gather, analyze and supply feedback in real time of relevant information from and to service technicians, support staff and product or service engineering personnel. Summarizing, management activities should focus on IT infrastructure investments that enable the use of flexible, scalable Service Management Systems. These IT platforms should provide flexibility by the ease of deployment and the ability to connect new sources of data and scalable solutions that includes the entire IPS^2 lifecycle and foster the vision of a real time, single-source-of-truth approach.

As a second field of action, management attention should focus on Quality Management Systems (QMS) that are customized to the individual demand of IPS^2. The purpose of a QMS is to secure a quality level that fits internal and external requirements. Regarding the information exchange in the IPS^2 lifecycle, activities focus to secure and improve the quality of products, services and their corresponding processes. Target figures may be distinguished by customer-centric, service-specific and company-specific metrics to ensure an adequate information quality and a consistent and complete history of product or service tasks. A tight integration of the QMS based on the same real-time IT platform can bring the level of services to the next level of servitization. A User Interface, tailored to each role within the value chain, will ensure a better informed decision making on quality issues and a predictive management of potential quality challenges.

Third, customer integration is the basis for establishing profitable, long term customer relations. An open and strategic exchange of information, going beyond the pure data-based information acquisition, is helpful in revealing changing customer requirements or evaluating the perceived service quality level. Thus, feedback meetings on a regular basis help identify changing customer needs, specific requirements and in deriving a requirements list solving individual customer problems and demands (Schuh et al. 2015). Additionally, integrating customers into the development of IPS^2 strengthens the customer loyalty leading to a higher willingness to outsource internal service processes. Therefore, management should try to establish strategic partnerships with key customers and suppliers, also including regular feedback meetings, open-innovation-approaches and shared product/service development in order to integrate external innovation capabilities into their own organization. The use of an IT collaboration platform, where customers, partners and key internal stakeholder can interact virtually and share information, allows to scale up both the customer interactions and to increase interaction between physical meetings. It also ensures data confidentiality when interacting with competing stakeholders.

6 Conclusion and Key Learnings

In summary, the idea of exchanging information between the service front-end and the early stages of the development of IPS^2, and vice versa, is not widely known. In this study, we offer the hypotheses that, based on our research, support the potential success factors behind companies that achieve a high level of efficiency and innovation through information exchange. Furthermore, we claim that theses hypotheses are key to designing an information architecture that supports an efficient and, at the same time, innovative organization. We tested these hypotheses to identify the variables that have a significant impact on performance, in terms of information acquisition, analysis, use, and distribution. Using a database, based on answers to a questionnaire distributed to members of the German manufacturing industry, we identify five hypotheses that have a positive impact either on innovation capability, service excellence, or both. For service excellence, relevant factors proved to be the ability to generate product information on the basis of engineering efforts, and the extent of information quality.

For innovation capability, a relevant dimension is an organization's ability to generate product and service information for training and qualification issues. Besides, we have noted the ability to establish an integrated product and service history as important to establishing explorative organizational skills. Finally, the ability to acquire information from service influence is reflected in both performance dimensions. Furthermore, we examined successful companies to reveal best practices that deepen and exemplify the factors of a successful information exchange across the IPS^2. We have highlighted these best practices along the IPS lifecycle, following the four categories of information creation, training and qualification, service delivery and optimization of service delivery. We completed our research by drafting a first set of management guidelines that may help practitioners focus their attention on three different areas: IT-systems, quality management, and customer integration.

However, the conducted empirical analysis, by design, comes with limitations. The hypotheses were based on our understanding of what the relevant success factors along the IPS^2 lifecycle are. Other authors on the subject may take different perspectives. Also, the data gathered from our survey of the German manufacturing industry was limited and reflected only an extract of successful practices in a specific industry. Therefore, future research could adapt our approach to other industry segments to validate our results for robustness and transferability. In particular, our results in the German manufacturing industry could be validated by conducting case studies to generate an in-depth knowledge for manufacturing practices. Likewise, the impact of quality management, IT-systems, and customer integration on performance could be examined in detail through additional empirical analysis.

Key Learnings

- Two major trends are driving many companies in the manufacturing industry to rethink their business logic: applying a service dominant business logic, and collecting and using information about the market.
- The creation of industrial product-service systems, with information exchange and usage of field service data and engineering, aids the generation of new business models.
- The design of an adequate information architecture and the subsequent management model are the key factors for a successful implementation.
- Five success factors have been identified with a significant impact on either innovation performance and/or operational performance.

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Gerhard Gudergan works as senior lecturer at RWTH Aachen University. Gerhard Gudergan is founder of the Service Science Innovation Lab at RWTH Aachen Campus. He is member in different expert groups on service science and service innovation and standardization. He holds a master and a Ph.D. in mechanical engineering from RWTH Aachen University. His research interest focuses on organizational transformation and design and innovation in services.

Achim Buschmeyer has a master's degree in business administration and economics from RWTH Aachen University and the University of Hagen. Since 2012, he has been the project manager at FIR at RWTH Aachen University. Buschmeyer is deputy head of the department Business Transformation. His current work focuses on business model innovation and servitization in production companies and the related transformation strategies.

Boris Alexander Feige holds a master degree in business, management and economics from RWTH Aachen and a bachelor degree in aeronautical engineering from University of Applied Sciences Aachen. Since 2013, he is a project manager and research assistant at FIR at RWTH Aachen University. Beside guiding several consulting projects, his research activities focus on organizational issues in the area of Business Analytics.

Denis Krechting archived his masters in Industrial Engineering at the TU Dortmund University. In 2014 he started as project manager at FIR at RWTH Aachen University where he was certified as Business Transformation Manager. Currently he is focused on the impact of new technologies on producing companies and the consequential service opportunities and inherent transformation strategies. Additionally, Krechting is a seasoned business advisor within the automotive industry.

Stefan Bradenbrink has worked 12.5 years as system independent consultant for national and international clients in various industries and divisions with focus on Technical Information and Service Processes. Afterwards he has worked 5.5 years as Business Development Manager in an American software company responsible for Service Lifecycle Management aligned with Product Lifecycle Management. He holds a Ph.D. in Physics from the University of Bielefeld.

Ralph Mutschler works in the Business Transformation Services in the Center of Expertise Innovation at SAP. He has worked on engagement on innovation/transformation in several industries, ranging from financial services, high tech, industrial goods, mining and metals, and transportation. He has 15 years of work experience in IT and management consulting. He holds a master's degree from Arts et Métiers Paris Tech in France and a M.B.A. from the University of Michigan, Ross School of Business in the United States of America.

Part III
Use Cases

Creating a Market Analytics Tool that Marketers LOVE to Use: A Case of Digital Transformation at Beiersdorf

Jan vom Brocke, Maria Fay, Martin Böhm, and Volker Haltenhof

Abstract Beiersdorf transformed how it works, and it did it through digital technology. However, it was not the technology that transformed the work; it was the people. The joint team from Beiersdorf and SAP established a solution that marketers *LOVE* to use: a *L*ean process to produce the expected *O*utcomes that bring *V*alue to users and create *E*xcitement among the project team, Beiersdorf's stakeholders, and most importantly, the outcomes' users. Although technology enabled many of these changes, users' needs were always a key focus and criteria in selecting the most essential features and constructing the final products.

In 2013, Beiersdorf undertook a key initiative to leverage the full potential of globally available retail data and go from generic reporting to dynamic analytics and insights. A co-innovation process among business, IT at Beiersdorf, and SAP developed a user-centric market analytics tool that sets a solid foundation for a common global view on markets and product categories in a simple, intuitive, mobile, self-service mode. The project is an example of the possibilities that can be uncovered by new methods of data harmonization and data analytics. It allowed the company to re-imagine business processes through automating analytics and to re-imagine work by moving from 'what' to 'why'. In part, the project even let Beiersdorf re-imagine the business model of the marketing analytics department, which became a central unit for analytics-related topics in the company.

J. vom Brocke (✉)
University of Liechtenstein, Vaduz, Liechtenstein
e-mail: jan.vom.brocke@uni.li

M. Fay
University of Liechtenstein, Vaduz, Liechtenstein

SAP (Schweiz) AG, Regensdorf, Switzerland
e-mail: maria.fay@sap.com

M. Böhm
Marketing/Sales Technology & Analytics, Beiersdorf AG, Hamburg, Germany
e-mail: martin.boehm@beiersdorf.com

V. Haltenhof
SAP Deutschland SE & Co. KG, Walldorf, Germany
e-mail: volker.haltenhof@sap.com

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The case is an example of how digital technology goes far beyond the technology itself by building new digital capabilities in an organization and stimulating a new loop of further transformation. In this journey of digitalization, Beiersdorf sought not only to reach the final goal but also to lead so others follow.

1 Introduction

How do you transform a company that has more than 130 years of expertise in research and development, 17,000,000 employees, and annual group sales exceeding six billion euro? In this case of digital innovation, we report on the unique example of such a transformation at Beiersdorf—a project carried out with the aim of making marketers' lives easier that in the end changed how the entire company works and thinks.

Why transformation and market analytics? Beiersdorf, a global market player, invented modern skin care and owns an iconic global brand, NIVEA, which accounts for the lion's share of its business. With many strong global competitors, Beiersdorf must have clear insight into local and global market share development, overall market conditions, and competitive moves in order to respond effectively to market changes. The market share KPI is essential in steering a global brand like NIVEA and ensuring the continued health of its brand.

This case of digital transformation builds on a project that began in early 2013 involving Beiersdorf's marketing analytics department, which manages brand performance measurement and is engaged in developing the product pipeline and planning marketing activities. The marketing analytics department plays an 'enabler' role in the company by providing market analytics and competitor profiles to many business departments in support of effective, data-driven decisions.

With the emergence of new social media platforms, marketing specialists are introducing changes to their promotion and marketing plans because they now have more ways to interact with customers. However, marketers need to justify their business value by showing the effect of these activities to the company's key stakeholders and decision-makers. Competing in a demanding marketplace like that of skincare requires going beyond realizing 'what happened' and asking questions like how and why it happened and how to ensure it happens/does not happen again.

Because traditional *generic reporting* tools no longer satisfy business requirements for analysis and are too time-consuming and prone to error, more powerful, real-time *dynamic analytics* solutions are needed. SAP, a major player in the field of Big Data analytics technologies, notes that "the key is unlocking data to move decision-making from Sense & Respond to Predict & Act." (SAP 2012, p. 5).

Beiersdorf implemented one such dynamic analytics solution based on SAP HANA. Initially planned as a back-end optimization, this project provided the necessary real-time view of brand performance on both the local and the global level. It also triggered a large co-innovation process that has changed the company's perception of analytics and repositioned the marketing analytics department in the company.

This case is an example of how digital technology can build digital capabilities in an organization and can help it to go beyond technology to create new business opportunities.

2 The Context: Digital Innovation at Beiersdorf

Beiersdorf, a global player in skin and personal care in the market of fast-moving consumer goods (FMCG), must be able to stay proactive at the market, and make informed decisions about key strategic areas like advertising and promotions. The company's marketing specialists also require information about product sales and market share for multiple product categories across all regions worldwide.

With market data distributed among hundreds of retail databases that had to be consolidated monthly, a dedicated team worked to harmonize the data from the big syndicated data providers like Nielsen, IRI, and Aztec, a time-intensive process that was prone to error because of the manual work involved and that resulted in a time delay of several weeks in delivering a monthly report. Moreover, traditional analytics tools did not provide views from a brand level down to the most granular level of stock-keeping units (SKUs) or allow performance to be compared across countries. External analytics services were always required because in-house analytics cost more time and money.

Beiersdorf saw the need for a clear view of product/category performance and decided to streamline data-harmonization and consolidation. Initially, the project scope was primarily to create a new back end with a 'leading structure' and to have a common, global set of attributes to avoid mapping and matching of more than 800,000 product IDs. For example: if creating a report meant manually adding together all database entries related to 'women', 'woman', 'ladies', 'female', and 'girls' in the new tool attributes were assigned to the category 'female' in the global category of 'leading structure'.

Initially, all efforts focused on harmonizing the data. As a back-end solution, these changes resulted in accelerated and automated reporting of global market data. However, the next logical step was to support market-related decision-making, so Beiersdorf needed a new way to leverage data's potential and a more tangible outcome to demonstrate to stakeholders the system's full power. It became clear that the system's powerful back end had to be complemented with an easy-to-use front end in order to deliver 'one global view and one single-point of truth' to the business.

To ensure maximum value, the solution had to build on users' insights and provide users with opportunities they'd never had before. One example was to have a 'granular' view of the true impact of marketing and promotion initiatives on market share and other indicators. Moreover, the tool had to be so simple and intuitive that one could work in an explorative fashion by trial and error. The tool had to be a joint initiative and effort by its future users.

3 The Project: Developing a Global Market Share Analysis Solution

3.1 The Product

The project introduced a 'Guided Analytics' tool that lets users work with global market-share and product-purchasing data across product categories, and monitor the companies that have the greatest effect on the business. The tool not only shows numbers and raises questions, it also presents the trends behind the figures and possible answers and suggestions for what to do differently. Marketers can now access detailed reports on any product category, country, or region quickly and easily from their desktops or mobile devices. In the end, specialists can proactively develop new discounting promotions or change the marketing mix, saving both time and money through more efficient decision-making.

The Guided Analytics tool is an interface to hundreds of databases from various sources (e.g. retail panels, point-of-sale, and media). Based on this data, aggregated reports across categories, countries, regions, and products are generated along with a way to look deeper into each of them. The solution manages, harmonizes, and analyses massive volumes of data with the help of SAP Demand Signal Management application powered by SAP HANA.

The final product was developed with the end-user at the center of the solution, and users' needs were key criteria for selecting the most essential features as separated from the 'nice-to-haves'. This approach follows the technology affordances theory (Gaver 1991), which considers affordances to be "properties of the world that make possible some action to an organism equipped to act in certain ways." (p. 80). An example of a consumer product that adopts this approach is a cat door that affords passage to a cat but not to a person, while a technology-related example is an onscreen button that the user can select but not edit or move. A product's designer-defined properties afford (or trigger) actions, while users' culture, experience, education, and skill influence their perception of a needed action. While working on the Guided Analytics tool, the project team ensured that the interface was easy to use and that it provided only the essential possibilities for user participation while running complex technical tasks in the back end.

Table 1 summarizes the solution's key technical advantages at two levels: data harmonization and data consumption (analytical possibilities).

What does the solution mean in a real-life marketer's setting? Marketers can see monthly market-share development for a set of countries that highlights, for instance, the top 'gainer' and 'loser' brands (Fig. 1).

Table 1 Key solution characteristics and the possibilities they create

	Before	After
Data harmonization	More than 400 databases with different data structures, put together manually	A common, globally valid standard for all categories as a unique source of unbiased information, with the databases processed automatically
	Delivery of reports in several weeks	10–15 times faster delivery of reports
	No way to conduct a root-cause analysis for brand-level data	Full root-cause analysis on a single-product level (individual SKUs)
Data consumption	No way to ‘drill down’, resulting in a lack of granularity	Full granularity provides a ‘helicopter view’ and allows the user to drill down to a single-product level in order to, for example, display ‘gainer’ or ‘loser’ products
	Performance for one country at a time	Tracking performance across several countries or regions at a time

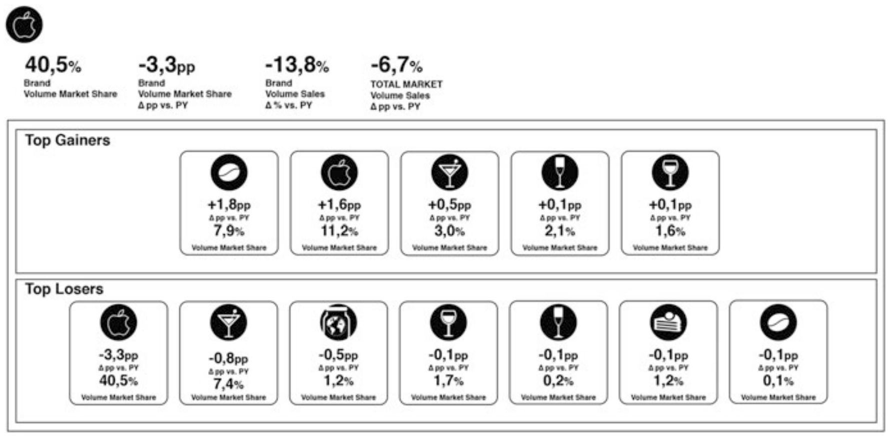

Fig. 1 First indicators of ‘gainers’ and ‘losers’ in the market using the guided analytics tool (adapted from Beiersdorf AG)

In only two clicks, users can get a deeper view of the top gainers (brands that drive changes in market share) through ‘volume market share’, ‘brand volume sales’, ‘brand average price’, and other indicators, in both absolute and relative values (Fig. 2).

A user can also drill down to the product fact sheet or investigate the key facts about the root causes of a change in market share on a product level (Fig. 3).

Apart from the possibilities the tool already provides, there are many other potential benefits, ranging from performance measurement, or social analytics, to scenario-modelling of promotion activities. It is now possible to re-imagine how the launches of products or brands are launched, to get new market views through all of

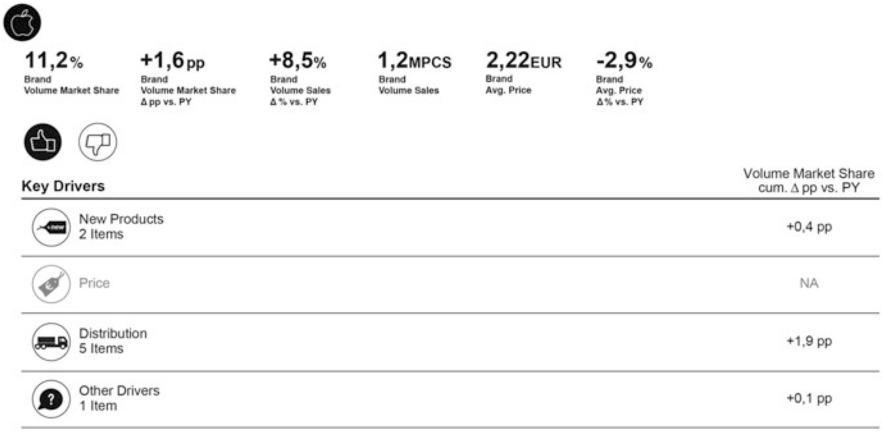

Fig. 2 Key root causes of brands' performance using the guided analytics tool (adapted from Beiersdorf AG)

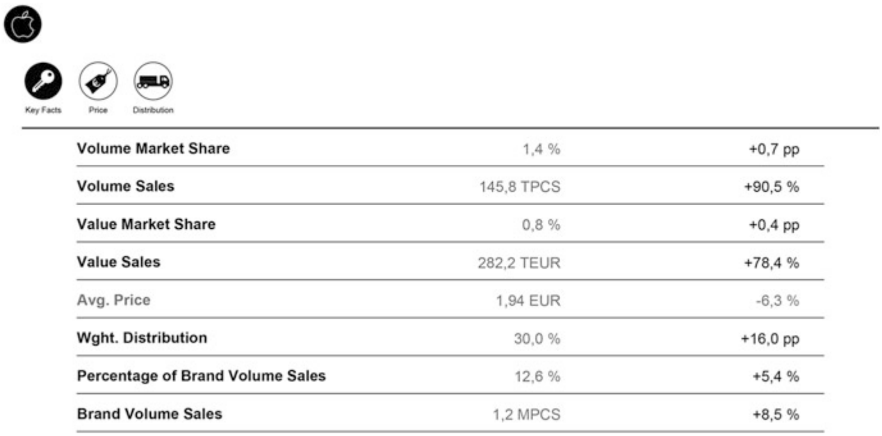

Fig. 3 Detailed view of each root cause on a product level using the guided analytics tool (adapted from Beiersdorf AG)

the data from individual accounts that are consolidated in the system, and to see the real impact of marketing and media activities.

3.2 The Approach: Design Thinking

Beiersdorf and SAP as a co-innovation partner to manage their work on a front-end solution that would create a truly creative technological solution that meets (and exceeds) business users' needs. To meet this objective, the team followed the

Design Thinking approach offered by SAP Service Innovation and Business Transformation Services (BTS).

The *Design Thinking* approach was first developed in the 1990s by IDEO, one of the world's largest design agencies. Design Thinking made a huge leap toward mainstream adoption when the first Design Thinking school (D-School) was opened in Stanford University in 2005. A few years later, SAP founder Hasso Plattner lent his support to the project, resulting in the creation of the second D-School at Hasso Plattner Institute in Potsdam (HPI), alma mater to many software engineers and IT specialists. Students of the HPI School of Design Thinking apply the key principles of Design Thinking in IT and to improve users' experience and the solutions' customer-centricity radically. SAP adopted this approach in the mid-2000s, and today there are over 400 Design Thinking coaches worldwide—primarily full-time consultants with many years of experience and industry expertise—who are bringing this knowledge to customer projects.

The core components of Design Thinking are the '3Ps'—people, place, and process—the purpose of each of which is to find innovative solutions at the intersection of business viability, technical feasibility, and human desirability. This framework also resonates with the framework from Rhodes (1961), who outlined the 4Ps of creativity: person, process, product, and place. As the 'product' (described in the previous section) was created as an innovative solution, its relationship to creativity is well-established. The other three elements are similar to the Design Thinking 3Ps, where 'people' refers to the multidisciplinary team with a culture of empathy, 'place' refers to an environment with a culture of trust and the space/material for creative teamwork, and 'process' is highly iterative (outlined in Fig. 4).

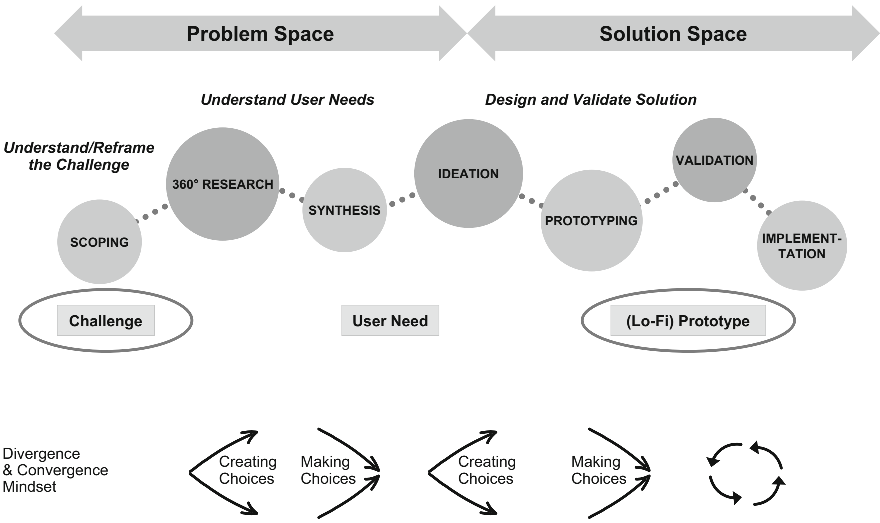

Fig. 4 Design thinking process (*Source*: SAP Service Innovation)

The motivation for selecting Design Thinking as an approach for the Guided Analytics project was to create innovative solutions (products and services) at the intersection of technology, business, and human values. Let us take a look at the core attributes of Design Thinking described by Baeck and Gremett (2011), specifying how they were addressed in the Guided Analytics project.

Collaborative, Empathic, and Encouraging Curiosity Design Thinking fosters an open culture of collaboration that inspires creative, multidisciplinary teamwork with user-centricity as a core value. A large part of the problem-solving activity consists of problem definition and problem shaping and exploration in search of the solution that addresses the customers' key need. The most 'wild' ideas are encouraged in this approach, as they facilitate creativity and trigger out-of-the-box answers to the questions raised.

A Constructive, Non-Judgmental, Open Mindset Another important aspect of the Design Thinking approach is how one perceives failure. Ideally, you learn something each time you fail. An environment in which failure is not only acceptable but even encouraged (or provoked) stimulates creativity (von Stamm 2008). At the same time, old ideas that were not once defined as 'the best' can serve as a basis for new ideas that lead to successful solutions.

Iterative, Holistic, and Addressing Ambiguity The Design Thinking approach is highly flexible because it can begin from any phase and go through any number of iterations necessary. It is also applicable in any industry or project (Plattner et al. 2010). All of the Design Thinking approach's elements are intended allow the team to frame the right problems, to ask the right questions while developing a solution, and to choose the best ideas from a set of alternatives. It leads to discovery and to solving challenging problems while addressing the core need of the user (or 'Persona' in Design Thinking terms).

The classic Design Thinking process consists of five major steps: Understand → Observe → Ideate → Prototype → Test. SAP named these key phases differently to make them more appropriate for consulting projects and software development (SAP 2014). Figure 4 shows the naming and structure of phases as applied in the Beiersdorf case.

Design Thinking is a process of at first 'creating choices' while gathering facts about the problem, then 'making choices' to define the key problem for which the final solution will be developed, then again 'creating choices' for brainstorming and ideation on the possible solutions, and again 'making choices' to choose the one option that will be further prototyped and tested. This constant transition and change allows the design group to stay open to new ideas and always to be ready to go backward in the process for another round of brainstorming or low-fidelity prototyping if necessary.

Design Thinking played a key role in the Beiersdorf case because it helped facilitate the acceptance of the project and its solution, and it ensured a quick start. Accenture (2011) highlights several stages of change acceptance: Awareness → Understanding → Support/Involvement → Commitment → Action.

At first stakeholders must be supplied with information (to create awareness and understanding), then trust toward the project must be built to ensure support, and finally users become ambassadors for the final solution, facilitating change and taking action.

In the Beiersdorf case, Design Thinking built *awareness* about the project through the workshops with users (at the same time, *doling out* information to keep the project *under the radar* until the first roll-out). Then, it encouraged *understanding* of the nature and intent of the proposed changes and how the final product would influence the lives of the people involved—that is, the users (marketers), C-level stakeholders, other departments, and the project team members who manually harmonized the data (as their core activities were about to change). The changes would go beyond Beiersdorf to involve their data providers, whose services would no longer be required in the volume once needed. Finally, Design Thinking helped to ensure the *support* and *involvement* of the team members and stakeholders, who consequently worked toward the envisioned result by providing the necessary resources and decisions. Only two Design Thinking workshops were needed at Beiersdorf to ensure a quick start, build awareness, and encourage understanding and support for the project.

Another important difference between a Design Thinking project and a typical IT project is the approach to communication. Classic project management implies constant communication with the users involved, and the majority of projects start with multiple newsletters and promotion campaigns, setting expectations high. However, through the Design Thinking approach, the project team involved users from the beginning, and the team delivered only the features that users were excited about. That said, the classic IT project management approach is certainly applicable to projects with low innovation components and those that are in a critical stage and need fast and efficient decisions (see Fig. 5). The Design Thinking approach at Beiersdorf was a better match for the user needs involved, and it set the right environment for rolling out the final product.

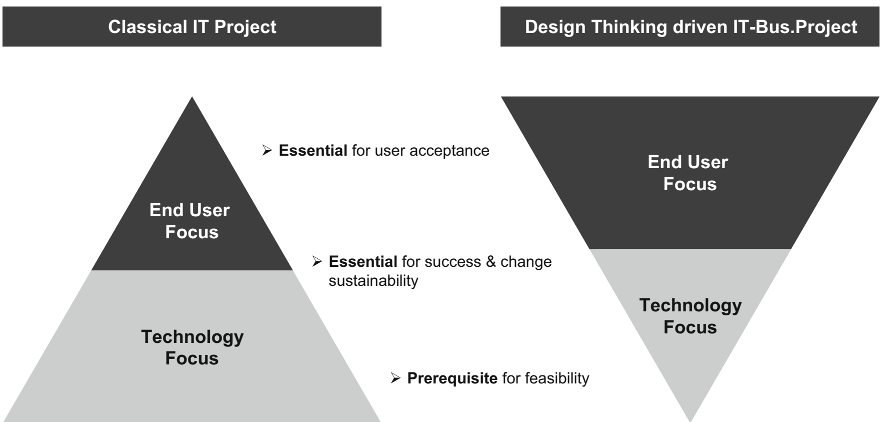

Fig. 5 Design thinking-driven IT-business/digital innovation project versus classical IT project

3.3 The Approach: Co-Innovation

Design Thinking became an essential part of a larger co-innovation process Beiersdorf and SAP established for this project. The Guided Analytics project team included Beiersdorf marketing analytics specialists, Beiersdorf IT specialists, SAP business consultants in the service innovation area, and SAP software developers. The process enabled co-creation, which triggered a significant leap forward in the project by using well-established co-creation principles, as mentioned in Ramaswamy and Gouillart (2010):

- Stakeholders won't wholeheartedly participate in customer co-creation unless it produces value for them.
- The best way to co-create value is to focus on all stakeholders' experiences.
- Stakeholders must be able to interact directly with one another.
- Companies should provide platforms that allow stakeholders to interact and share their experiences.

In the following, we outline how those four principles applied in the Beiersdorf case.

3.3.1 Stakeholders Won't Wholeheartedly Participate in Customer Co-Creation Unless It Produces Value for Them

In the first Design Thinking workshop, the overall design challenge was formulated as 'creating a market share analytics tool that marketers love to use' The emotive component of the challenge remained vital throughout the whole project, as users' emotional attachment to the solution was triggered by both the solution interface (appearance) and characteristics (benefits) it provided. Moreover, the project was not pure IT but a business project that provided a solution to a real business challenge, so the users had much to gain by participating.

From start to finish, the project team involved key users and stakeholders in workshops, interviews, and testing to ensure that the design addressed pain points and desired outcomes. This involvement was limited to avoid information overload while still addressing the interests of all parties.

The project team used the term 'submarine approach' to refer to getting the job done without creating unnecessary waves and turbulence. That approach also involves surfacing periodically to the stakeholders and users to let them know where the project stands and to gather feedback to ensure the project is still on the right track. While the core project team 'lives' in this submarine, they are free to choose their surfacing strategy—sometimes surfacing to show what is possible, and sometimes diving deeper into the problems or solutions. The academic background for the submarine approach can also be found in the lean management philosophy, an aspect of which is to reduce waste, so the team followed the philosophy of communicating only when they had something to say but making sure their stakeholders and users were following them.

Another key to this project was the two-way nature of the communication. The project team kept users updated on the project's status to let them know it was on track and ensure their support, and users were invited to share their views throughout the process. As Ramaswamy and Gouillart (2010, p. 100) suggested, if you "give all your stakeholders a bigger say, [. . .] they'll lead you to better insights, revenues, and profits."

3.3.2 The Best Way to Co-Create Value Is to Focus on All Stakeholders' Experiences

The final product was a tool designed *by* and *for* the user. The product generates insights that help marketers as primary users, as well as users from other departments. The data the tool generates also benefits the finance department with its sell-in/sell-out reports by explaining peaks in sales for a market category or a brand. Supply chain specialists can leverage the tool for their demand-planning programs, and for communication specialists, the tool provides a way to support claims in product campaigns or to launch a new, targeted offer.

The interests of all these parties were gathered during the initial phase and then incorporated into the solution in order to deliver a final result that exceeds expectations. The process reflected Ramaswamy (2011, p. 195) observation that "co-creation is the process by which mutual value is expanded together."

3.3.3 Stakeholders Must Be Able to Interact Directly with One Another

The Design Thinking approach involved stakeholders from the business units continuously as users. Interviews were conducted to gather requirements and feedback on the prototypes, and during the two Design Thinking workshops a team of Beiersdorf and SAP specialists worked on making the solution intuitive to ensure rapid adoption even without additional training. This interaction facilitated an iterative development of the front end, resulting in a tool that delivered exactly what the marketers needed (and were excited about). Another factor in achieving this result was that the interface used a common business language in place of IT acronyms, and because of the consultants' business backgrounds, there was a common FMCG-based understanding of the problem and the solution space.

3.3.4 Companies Should Provide Platforms that Allow Stakeholders to Interact and Share Their Experiences

The overall challenge was to satisfy the many demands concerning what information should be available and how it should be visualized.

Driven by four allies (Beiersdorf business and IT, SAP business and IT), Design Thinking workshops became a platform for users to interact while developing the front-end tool. It also reduced resistance to change and avoided the 'not invented here' issue. Traditional project management tools like status reports and issue lists were used, but the number of decision meetings was reduced in favor of maximum freedom and a high level of agility through Design Thinking and intensive iterative test cycles.

3.4 The Process

Vom Brocke and Schmiedel (2015, p. 7) list the advantages of process innovation, which were well demonstrated in the Beiersdorf case:

- Directly draw on people's experience.
- Often does not need heavy engineering.
- Can take place with any technology.
- Can be deployed globally.

SAP Consulting, Beiersdorf IT, and licensed SAP partners created the technical blueprint for process innovation together. It was important to have the right colleagues on board who had profound knowledge in the area of retail panel/syndicated databases and could translate business needs into technical requirements. The project followed a standard procedure: (1) define the business challenge and identify the business case; (2) determine how to obtain the data, whether all data are available, and whether the data allow for global scalable processing; (3) and deploy the model to make data actionable.

Work on a back-end solution started in early 2013 in an effort devise a way to manage external market data sources in one environment. In order to adopt a more agile approach for the front-end definition (iterative testing phases and fast realization of the business and technical blueprint) and maintain pace, the back- and front-end projects were separated into two processes.

The company followed a top-down approach initiating the project, first aligning with headquarters' top management and then with all relevant global business units. Then alignment was cascaded to general managers and marketing directors of affiliates before bringing all relevant business units across the globe on board.

Work on the front-end solution started in autumn 2013 with the first Design Thinking workshop. Conducted at SAP Headquarters in Walldorf, the workshop sought to create a tool that marketers would *LOVE* to use. The workshop resulted in a *L*ean process to produce the expected *O*utcomes that bring *V*alue to users and create *E*xcitement among the project team and the company's stakeholders, and the outcomes' users. In the following months, the project team conducted deep-dive interview sessions with the key users and stakeholders as an essential part of a research phase. In spring 2014, the second workshop took place at Beiersdorf headquarters in Hamburg, beginning with a test of the first prototype for the workshop's participants. Only 6 months later the solution went live for the first key users, and after another 6 months the solution was ready for a full-scale go-live release, followed by regional roll-outs that are still going on.

Workshops, co-creation activities, and the constant presence of project sponsors and the team involved many stakeholders in creating the tool, from ideas on sticky notes to low-fidelity prototyping. As part of a validation process, future users of the system were assigned a set of tasks that represented what they might do on an average business day. All of the tasks involved some data-exploration activities (e.g., why have product sales in X category dropped? What are the market dynamics in the UK?), and users had to work toward finding the answers using the tool. While the participants worked, the project team captured the problems and successes users encountered in using the tool through in-person observation, eye-tracking tools, and post-task interviews. This process proved highly effective and helped to make the tool more user-friendly and efficient.

With their individual involvement and contributions as essential elements of the solution development, the users were eager to engage even more and often asked for updates on the project status. Users also acted as ambassadors for the tool by distributing rumors about it and creating a buzz.

4 The Effects: Changing How Beiersdorf Works

The solution presented by the Guided Analytics project has had a significant impact on the company in terms of both direct and prospective benefits. With it, the company has taken a step toward becoming a data-driven company. We describe five key areas where the solution that is now in place has had the biggest impact: culture, organization, sourcing, process, and IT (Fig. 6).

4.1 Culture

The project has demonstrated that *innovation is broader than products*. Innovation focuses on improving the users' experience and stimulating additional ideas for improvement. At the final phase of the project, business users were positive about the results and excited about implementing similar solutions in their areas of expertise, suggesting new customized functionality and reports that were particularly relevant to their areas. Numerous ideas regarding potential reports and

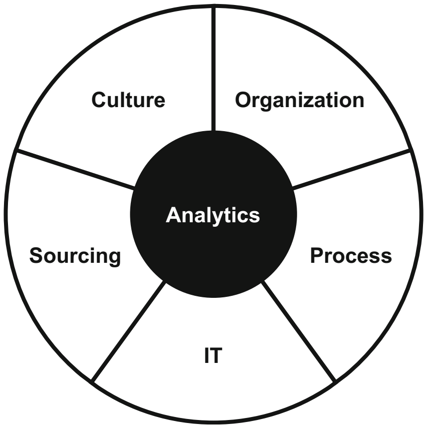

Fig. 6 Impact of the guided analytics project on the enterprise

analytics generated by the solution emerged; in fact, the possibilities revealed by the Guided Analytics tool sparked thousands of ideas.

This engagement has clearly changed the value of those involved in the project and, thus, the organizational culture at Beiersdorf (vom Brocke and Sinnl 2011; Schmiedel et al. 2015). The Design Thinking approach has set a *mindset where failing opens new potential for improvement*. 'Failing early and often' which is one of the key principles of Design Thinking, allows participants to test, experiment, take risks, and succeed more. Moreover, it is possible to adopt *'convergent' and 'divergent' mindsets at the same time,* to both focus on the problem and explore new opportunities, a valuable combination for making choices about an innovative product or solution.

Finally, to guarantee the project's success, the *project management culture* had to adapt to taking an iterative approach to problem-solving: if a new round of brainstorming or testing was needed, the project team did it because it helped to create a customer-centered solution and avoid problems at later stages.

4.2 Organization

This solution has *triggered global harmonization* within the company. It set up momentum in analytics tasks by showing how easy and productive analytics can be. Apart from the tool's work benefits, the project also resulted in a certain return on investment (vom Brocke and Sonnenberg 2015) because of the cost savings in using the tool and made the role of data analytics more visible. The marketing analytics department, which implemented the tool, overcame all the obstacles and is now seen as the owner of harmonization and analytics in the company, with the potential to create a culture to establish a 'digital' business unit for all enterprise analytics. The Guided Analytics tool *sets the foundation for all datasets* *in the company*, and it can be leveraged to help the company make better, more accurate decisions in shorter timeframes.

The *business model* of the marketing analytics department has been re-defined as a result of the project. Providing service to multiple divisions, this department is now recognized as the leader on the topic of advanced analytics and Big Data in the company. Many other divisions and regions ask for customized reports, while the marketing analytics department already makes cross-country and regional reports. Moreover, only a year after its introduction, the solution has already doubled the initially planned number of 300 users of the tool, and that number may increase to as many as 1200 active users in the next year.

Another important benefit reported in this case is a new level of *employee empowerment*. Guided Analytics enables marketers to provide answers to questions about changes in market share and to be better informed when they engage in conversations with country marketing managers. The *roles within the marketing analytics team itself have also been redefined*: employees who once manually assembled data from all the databases for analytics now act as advisors, data visualizers, and data modelers. After some initial apprehension about their new responsibilities and unfamiliar tasks, users accepted and embraced these changes and soon welcomed them. Because they no longer have to harmonize hundreds of databases manually and risk making errors or missing deadlines, users now have time to 'dig deeper'—discover new insights, adopt the role of 'data scientist', and steer the system. Empowerment contributes to employees' having a much higher quality of life and avoiding burnout. While increasing employee satisfaction, the new solution also increases the value that employees bring to the organization, creating a win–win situation.

Finally, the project has contributed to *redefining the business team* such that the company is now investigating solutions that could run in 'self-service' mode, which involves looking at the business from a new perspective and satisfying demands for customized reports from the company's regions and divisions.

4.3 Process

The Guided Analytics tool triggered the company to take a step *from static reporting to dynamic, insightful, and powerful analytics,* which is the nucleus of the solution. Using the framework SAP suggested (Fig. 7), the company has made a significant leap forward, from asking 'what happened?' to 'what will happen?' and 'what is the best that could happen?' The maturity of analytics capabilities, along with the expanding capacity for generating collective, business-focused insights, enables analytics to be presented in storytelling mode—analytics that not only respond to market dynamics but can also predict and drive them forward. The tool has helped the company to transition from 'Guided Analytics' to 'Guided Exploration', where it identifies patterns and creates a basis for 'explained analytics'.

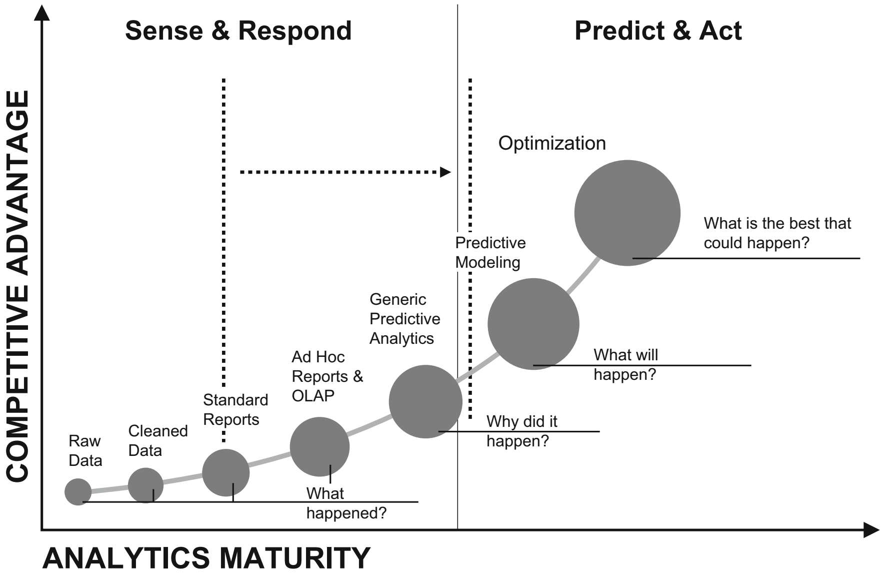

Fig. 7 Evolution of mature analytics capabilities (adapted from SAP 2012)

The solution has also helped the company to achieve *high efficacy* across the affected business units. Administration, reporting, and distribution of external market data throughout the company has never been this simple and intuitive. Automatic data harmonization has dramatically *reduced the time lag* between global and local market reporting. Decisions made when reports are published can now be made *with fewer delays and errors*. There is no longer a need to send PowerPoint slides of key market share indicators to stakeholders because all information is now available on the platform.

Equally important, through *fast and insightful reporting*, the first market trends become transparent earlier, which lets users initiate necessary actions in a timely manner. Analytics that are based on various product attributes enable users to collect marketing analytics and gain insights into the dynamics of market share.

All these possibilities have evolved from a *single global definition* that allowed every data source to be harmonized and data uploading to be automated. Looking at the process of transferring data into a strategic asset (Fig. 8), with the tool in place, the results are clear: data collection has become a strategic asset: data processing is faster and more efficient, and data analysis provides richer insights.

Moreover, trading traditional reporting of analytical services for rich and flexible analytics saves money. In the short time that the tool has been in use, the company has achieved *significant cost savings* on its global syndicated data budget because it can now perform high-quality analytics in-house instead of contracting external consulting and analytics providers. The solution also leverages the wealth of granular data from syndicated research to increase the return on IT investment and decrease the number of errors. Some of the internal resources in brand

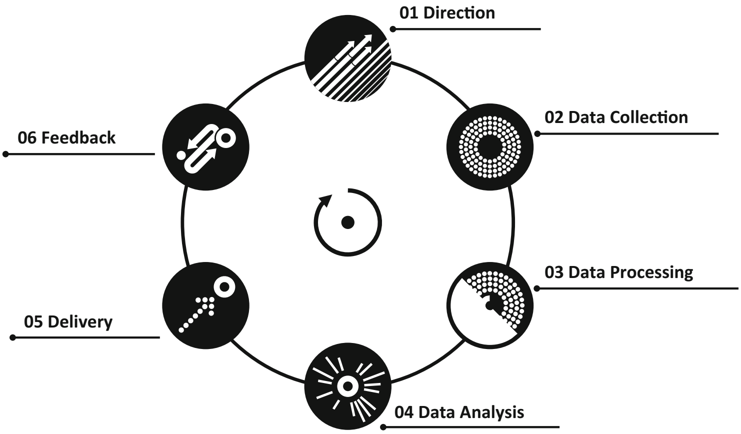

Fig. 8 Intelligence process—transfer of data into a strategic asset (adapted from Beiersdorf AG)

management can now focus on deriving meaning from the analytics, as they freed from manual and time-consuming operations.

4.4 IT

To a great extent, the project has encouraged IT to investigate new topics and gain more expertise in the field of Big Data and advanced analytics. IT has started moving toward entering the innovation chain, so the department's identity has changed; the whole enterprise architecture and the structure of IT investments have been re-assessed to address the challenge and need for a new partnership role for IT (Tumbas et al. 2015). To benefit from the potential of analytical capabilities, companies should build a value chain that goes

from *data management* (IT's area of expertise, answering the '*what?*' question)
→ to *data analytics* (marketing analytics department's area of expertise, answering the '*so what?*' question)
→ to *data use* (Marketers' area of expertise, answering the '*how?*' question).

An increasing number of companies acknowledge *the need for data scientists* in their organizations. As Davenport and Patil (2012) noted, such professionals should be able to wrestle with information "that comes in varieties and volumes never encountered before," but also to make discoveries, communicate what they learned, and identify new business opportunities. For that to happen, data scientists must be connected to business departments in order understand the challenges the business is facing. IT can then uncover compelling patterns and advise product managers and C-level executives on the data's implications for products, processes, and decisions.

4.5 Sourcing

The Guided Analytics tool triggered changes outside the organization as well, to the point at which it is *disrupting other companies' business models*. For example, market analytics agencies are losing a share of their business because, to a large extent, their services are no longer required. Companies have become more independent of their suppliers and external data platforms, and are instead sourcing information and creating their own data portfolios.

Moreover, now that a large part of data related to product performance and market share is available through the Guided Analytics tool, the procurement process can be more transparent. A corporate *sourcing strategy on the regional and global levels* helps to set up the procurement process in a way that leverages it by creating synergies and cost savings.

5 Conclusion and Key Learnings

The Beiersdorf case is an example of how digital innovation can drive business transformation that goes way beyond technology. It shows how a single solution can inspire employees to re-imagine their work. In this case, the 'Customer Centricity' of the solution became a powerful way to demonstrate the possibilities. By ensuring that technology supports the objective, Beiersdorf was supported by software but also able to influence development and benefit from early releases of SAP® software. Customer centricity made users identify more closely with the system and become actively involved in its development such that, as the project evolved, users became ambassadors for the solution. Such powerful internal promotion, together with technology and a strong brand, can open up new areas of ideas, projects, and inspirations.

Furthermore, close alignment and fast and effective decisions by business and IT were vital to the project's success. SAP actively involved consultants with market industry expertise that related to FMCG to ensure they could 'speak the same language'. The Guided Analytics project team included Beiersdorf, marketing analytics specialists, Beiersdorf IT specialists, SAP business consultants in the service innovation area, and SAP software developers. Having such a heterogeneous team fully corresponds to the classical Design Thinking principle of involving specialists with various experiences and skills in a project. In Design Thinking, so-called 'T-shaped people' can apply their functional knowledge across a variety of situations and leverage their multidisciplinary skills. The vertical bar of the T-shape in this case stands for expertise and functional knowledge, while the horizontal bar relates to skills like collaboration, empathy, and social skills (SAP 2014).

Questioning the status quo proved to be valuable. At first, the project focused on data harmonization at the back end, and it could have stayed this way; but to ensure support from the board and to aim for more advanced analytic opportunities, the powerful back end of the system had to be complemented by an easy-to-use front end that delivered one global view and one single point of truth to the business. In the future, even more value may be realized by moving to a self-service concept to satisfy demands for customized reports from various regions and divisions.

At minimum, a viable product has to be created that is exciting enough for people to like it—and possibly love it. At the same time, it should be simple enough to understand easily. One of the reasons that marketers support the Guided Analytics tool is that it supports them: users can now access detailed customized reports quickly and easily, and they don't need to read a user manual to do it.

The 'submarine' strategy the project team chose has helped to keep user interest at a high level while also ensuring the support of the executive board or IT steering committee from the early stages on. People became curious about the tool, so they were interested in it and did not focus on what the tool could have offered or lacked at the moment.

Beiersdorf's digital innovation journey began with the development of a Guided Analytics tool and then led to a powerful transformation process toward innovation and co-creation throughout the organization. By showing what is possible, the project generate a strongly positive attitude toward its goals in the company, while the Design Thinking process helped deliver the results. This case is exemplary in that it shows that digitalization in all its facets has become increasingly important for companies that want to make a shift in their mindsets to gain competitive advantage.

Key Learnings

- *Stay user-centric and always involve key business users so they can contribute to the IT solution*. Doing so ensured users' support and contributions, in the end increasing the value and acceptance of the final product.
- *Talk business, not IT*. Close alignment and speaking the same 'business language' ensured fast and effective decision-making and were vital to the project's success.
- *Have a dedicated team that remains the same for the whole project phase, and stay small and agile*. Because business and IT were represented from all sides, this team could leverage its functional and disciplinary skills and expertise, making the collaboration inspiring, valuable, and rewarding.
- *Keep it simple*. The user must perceive the solution as simple, like 'plug-and-play'. Avoid the temptation to implement 'nice-to-haves' before 'must haves'.
- *Keep it exciting*. Make people curious; they will be interested in the product or project because it is limited and exclusive and because of what it offers. Build a story behind the project, and create some results to impress.

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Jan vom Brocke is Professor of Information Systems, the Hilti Chair of Business Process Management, Head of the Institute for Information Systems, and Vice President for Research and Innovation at the University of Liechtenstein. An expert on digital innovation and transformation, he has published more than 300 articles and 29 books, including *Business Process Management—Driving Innovation in a Digital World*. Jan vom Brocke is an invited speaker and trusted advisor on digital business, serving many organizations around the world.

Maria Fay works for SAP Business Transformation Services, conducting research and leading executive training programs. She holds a master's degree with honors in business informatics and is pursuing a Ph.D. at the University of Liechtenstein, investigating the business value of advanced

analytics. Prior to joining SAP, she worked in a global technology consulting company and a large innovation center. Fay is an alumnus of the HPI School of Design Thinking and a business model innovation coach.

Martin Böhm is an expert in the area of marketing analytics and data-driven projects. As Global Head of Marketing/Sales Technology and Analytics, he is responsible for designing a future-oriented IT landscape to drive digitalization across digital marketing, e-commerce, analytics, and knowledge management. He has worked in various consulting positions, in brand management, and in the sales units of international FMCG companies for several years and has a proven track record of customer service excellence through creativity and innovation.

Volker Haltenhof is a principal consultant at SAP, focusing on global business transformation and innovation management. He has considerable experience working with major clients in Europe, South Africa, Singapore, and the U.S. Prior to joining SAP, he was a manager at Henkel KGaA in the areas of consumer and trade marketing, and category and key account management. Haltenhof studied International Business and Marketing Strategy at Bowling Green State University in the US and holds a degree from Saarland University in Germany.

Taking Digital Innovation into the Field of Infectious Diseases: The Case of SORMAS®

David Moyer, Daniel Tom-Aba, Shuchi Sharma, and Gérard Krause

Abstract Within the last several years the world has experienced outbreaks of infectious diseases across geographies in magnitudes of size and speed rarely seen before. People and governments worldwide have been impacted by these diseases, sometimes severely, and current processes used to track and trace infections were being seen as an impediment. As the Ebola outbreak was underway, governments were investigating ways to mitigate, control and reduce spreading of the disease. An objective was discussed and subsequently funded to determine if newer, mobile-based, technologies could positively impact processes and outcomes while increasing data accuracy during an event. This chapter describes how that objective was met through an innovative approach to managing infections at their source with mobile and real-time technologies identifying infections early in their cycle to contain and restrict them from becoming an outbreak, or worse, a pandemic. To address these challenges, several institutions jointly developed the Surveillance Outbreak Response Management and Analysis System—SORMAS®, field testing it in Nigeria during the summer of 2015 while the Ebola outbreak was still ongoing in West Africa. The proof-of-concept for SORMAS created new ways of tracing and tracking outbreaks in an integrated manner, while allowing field teams to monitor suspected cases in an effort to control the disease from spreading. The implication of using technology to transform processes, inform people and accelerate decision-making demonstrates, in this case study, the far reaching power of innovation and technology to save lives in countries where infrastructure and access to resources will remain a challenge for the foreseeable future.

D. Moyer (✉) • S. Sharma
SAP America, Weinheim, Germany
e-mail: david.moyer@sap.com; shuchi.sharma@sap.com

D. Tom-Aba
Helmholtz Centre for Infection Research, Braunschweig, Germany
e-mail: daniel.tom-aba@helmholtz-hzi.de

G. Krause
Helmholtz Centre for Infection Research, Braunschweig, Germany

Hannover Medical School, Hannover, Germany
e-mail: gerard.krause@helmholtz-hzi.de

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1 Introduction

The Ebola epidemic of 2014 rattled West Africa and the world with 28,000 reported cases of infection, of which 11,000 were fatal. This disease, not known about until 40 years ago, hit West Africa and spread to several developed countries, reinforcing the need for new ways of tracking, monitoring and responding to infectious diseases. There are over a hundred infectious diseases prone to cause epidemics, some of the more familiar are: tuberculosis (TB), human immunodeficiency virus infection/acquired immunodeficiency syndrome (HIV/AIDS), cholera, methicillin-resistant *Staphylococcus aureus* (MRSA) and various forms of influenza.

As a result of the Ebola outbreak, the German Center for Infection Research (DZIF) initiated a consortium of research institutes in 2014 with the purpose of closing gaps in knowledge and action in the fight against Ebola. One of these projects, titled, 'Ebola surveillance with mobile real-time data transmission in Nigeria' was initiated by the Helmholtz Center for Infection Research (HZI). HZI led a group of institutes in developing a Proof-of-Concept (POC) to track Ebola in Nigeria. These organizations were: Nigeria Field Epidemiology and Laboratory Training Program (NFELTP), Abuja, Nigeria; Bernhard-Nocht-Institut für Tropenmedizin (BNIT), Hamburg; Robert Koch-Institut (RKI), Berlin; Federal Ministry of Health (FMOH), Abuja, Nigeria; Hasso-Plattner-Institut (HPI), Potsdam, Germany and SAP America. A POC is a method of testing assumptions and solutions in a small measured approach prior to building a more complete product.

The team constructed mobile applications connected to a platform in the Cloud, using Design Thinking techniques where business processes, user interfaces and platform architectures were identified, built and tested. By leveraging in-person meetings with remote collaboration the team put a solution in the Nigerian field allowing for the capture of not only Ebola but also of avian flu, cholera and measles in a little over 7 months. Contact information for suspected cases was recorded and available to be viewed in real-time at the local, state and federal levels. In-country participating institutions included 16 local government administrations, 32 private and 32 public hospitals in urban and rural settings, and four state health supervisors. Over 150 physicians, epidemiologists, clinicians and governmental staff were involved during the 6 week POC in June through August of 2015 in capturing thousands of data points on patients, locations, symptoms and the spread of these diseases.

A brief list of the key requirements for Surveillance Outbreak Response Management and Analysis System (SORMAS) were:

- A mobile device capable of surveillance with mobile real-time data transmission in Nigeria.
- Real-time analytics that could be viewed by everyone with the appropriate access.
- An easy-to-use interface on both the mobile device and the platform.
- Little to no infrastructure or platform support required in Nigeria.
- Clear and intuitive processes for field and office staff to follow.

- Secure communication of patient status.

The result of the test was that the solution enabled collecting and managing infectious disease outbreaks through the use of mobile devices into a central platform allowing real-time analysis of the situation as it unfolded. Implications of this are considerable and compelling. A more efficient way of tracking cases of infection can put actual data into the hands of decision makers in time, thus potentially stopping or at least slowing down an outbreak and having direct resources at hand in places where they are needed most.

2 Background

Bacteria, viruses and other microbes have existed for millions of years before humans ever populated the planet. Due to their quantity, variety, and mutability this influence will either enhance our physiology or endanger our survival. Micro-organisms can mutate by orders of magnitude in speed and volume compared to humans, which is why humans will always be lagging behind in their capacity to evolve and outwit them. It also means that new pathogens are always going to emerge. Known pathogens are going to reappear with new characteristics that will be difficult to predict or even prevent. The challenge is to detect new threats quickly and to mitigate their effects by implementing effective containment measures as fast and as far reaching as possible and attempt to construct vaccines in an effort to slow down or stop these diseases.

Containing and preventing the spread of disease is, by most accounts, a new phenomenon. Our knowledge of the history of treating and preventing the spread of infectious diseases is quite short and limited in its nature. The Broadwick Street cholera outbreak in the city of London in 1854 serves as a great example for understanding how society began to understand the importance of sanitation and evolved in the treatment of epidemics (Hardy 1993). Dr. John Snow, a pioneer in the field of public health and epidemiology, made a map of the city, identified where people were dying, and then added this data to another map showing the location of water pumps in the city. It became clear that some of the pumps were contaminated with the virus, and were the reason why the disease was spreading. This marked the beginning of using data to study the spread of diseases. Once physicians studying the spread of various fevers made the link between contagion and sanitary conditions, a campaign to avoid contamination emerged. The earliest signs of public health and programmatic response grew from these campaigns and evolved to consist of the establishment of dispensaries and of special hospitals for infectious fevers. These dispensary doctors were the pioneers of public health.

Despite these burgeoning measures to contain infection, several pandemics have decimated large portions of populations over the course of the twentieth century. The Spanish flu virus of 1918–1919 is often cited as being the worst, as it infected 40 % of the worldwide population, and caused the deaths of more than 50 million people. In 1968 a flu virus emerged in China and killed approximately 34,000 people within 1 year. In more recent history, we have witnessed other influenza viruses such as swine and avian flus (Robert Wood Johnson Foundation 2013).

Today, the pandemic spread of disease has increased in speed, scale and complexity. With the opportunities for international travel created by our global economy, we now have an environment in which diseases can spread mercilessly across disparate populations which are then unable to quell their spread and coordinate a unified response. The international community is getting better at tracing infections but is still struggling to keep up with and to contain them. This matter cannot be understated. The recent Ebola outbreak in West Africa exceeded previous Ebola outbreaks in duration, geographic spread and number of cases by orders of magnitudes. Prior to 2014, outbreaks of the disease had not exceeded 300 deaths. In this most recent occurrence, however, the disease spread to six countries in West Africa and caused more than 11,000 deaths as of the end of 2015 (CDC 2015b), with some additional secondary cases resulting in Europe and United States.

The increased speed with which diseases spread is causing concern in many areas of the medical community. Upon reviewing the spread of a recent influenza virus in 2009, Harvey V. Fineberg, M.D., Ph.D., states in the New England Journal of Medicine Fineberg (2014):

> Even though there were areas of outstanding performance, such as the timely identification of the pathogen, the development of sensitive and specific diagnostics, and the creation of highly interactive networks of public health officials, the most fundamental conclusion of the committee, which applies today, is not reassuring: "The world is ill prepared to respond to a severe influenza pandemic or to any similarly global, sustained and threatening public-health emergency" (World Health Organization 2011).

Given the velocity and scale of spread due to international travel, the lack of clear and consistent methods to quickly respond and meet the organizational challenges of a robust international agency, it becomes clear that other nonconventional and technologically advanced solutions to address the prevention and spread of disease must emerge. These solutions need to be simple, cost effective and data driven. The most recent Ebola epidemic proved to be a testing opportunity for such a solution.

3 Situation Faced

Depending on the type of disease, infections can start with a small number of people and then move slowly into the local population. Others can infect large numbers rapidly, causing great concern and panic. Diseases can come from the environment, animals, food as well as from insects. One of the factors critical for containment is to understand the type, location and breadth of the infection so that appropriate numbers of resources can be called up in response. In most countries this is a manual, paper-based, process, in the course of which someone notifies the appropriate authorities which then send a staff member to investigate. They record pertinent information, may provide further information to the infected person on what and what not to do, and finally report back the incident to government officials. Being paper-based, this process can take from several days to up to as long as a month. Added to this is the complication of initial reporting times of the infection, the distance between an event and staff, the process of mailing or driving reports to local offices, of transcribing reports into computer systems and, finally, the actual reading of reports about the outbreaks, which consist of consolidated spreadsheets—all this taken together makes clear that time itself can easily become a contributing factor in the spread of infections. Finding a way to mitigate all these factors was one of the goals of the project.

In December 2013, the Ebola virus reappeared in a small village in the West African country of Guinea. It was not understood to be Ebola until 21 March 2014. By that point, the virus had spread to two of the neighboring countries, Liberia and Sierra Leone (World Health Organization 2014a).

On 20 July 2014, a Liberian traveler from Monrovia arrived at Lagos Murtala Mohammed Airport in Nigeria, sick and subsequently admitted into a private hospital. The Federal Ministry of Health (FmoH) was notified of a suspected case of viral hemorrhagic fever; it was confirmed to be Ebola virus disease (EVD). The patient 0 (the first patient case), died on the 25 July 2014. Contact listing and follow up started shortly after. The entry of only this single traveler into the country instigated the greatest challenge for its public health sector. Nigeria's ability to contain the outbreak would directly affect the likelihood of the epidemic to spread (CDC 2014).

At this time, World Health Organization (WHO) officially declared Ebola as a global public health emergency; and international coordination with governmental and non-governmental agencies (NGOs) started to increase (WHO 2014b). This coordination brought significant resources into the region: emergency shelters, isolation units, physicians, nurses, and security staff and support logistics (CDC 2014).

Nigeria mounted its own effort, in cooperation with international support, to contain the outbreak; and after approximately 3 months of coordinated efforts led by the Emergency Operations Center and partners, on 20 October 2014, having reached the required 42-day mark of no new reported cases, it was declared free of Ebola transmission.

The WHO commended the Nigerian government's strong leadership and effective coordination of the response that included the rapid establishment of an Emergency Operations Center and tracking of the virus to stop its spread in the country (World Health Organization 2014b).

4 Action Taken

SORMAS was developed to test the concept of using mobile devices in the field by trained staff to identify outbreaks of infectious diseases at the earliest opportunity. It was the result of a detailed analysis of current capabilities and processes, thereby creating new ways of tracing and tracking outbreaks in an integrated manner, while leveraging the latest technologies available. It also included developing new mobile applications, and a platform having minimal impact on operational staff. Finally, the team came up with detailed testing plans for field staff as well as for training on new processes and technologies.

During the initial outbreak, Nigeria successfully tracked contacts, those suspected or confirmed with EVD, using technologies consisting of applications written for smart phones using open source code. This provided faster recording and submission of contact information in an effort to respond more quickly into areas where the disease was taking hold. It also allowed field teams to monitor suspected cases in an effort to control the disease from spreading. This is evidenced by the difference in number of reported cases of EVD in West Africa (thousands) and Nigeria (28) as of 31 January 2016.

Concepts used and lessons learned during the original outbreak formed the basis for SORMAS, as the team extended the possibilities of additional features and functionalities with deeper applications and platforms.

The challenge was difficult, as the POC was to take place in sparsely populated areas of Nigeria. The technology, although well known in its parts and pieces had not been used in this way before. The SORMAS team therefore needed a different approach to identifying and solving as many of the problems as could be addressed in this short a time frame as possible. Design Thinking was the approach chosen to guide the team through design and development of a solution.

4.1 Starting with Design Thinking

Design Thinking is a methodology that begun in the mid-70's that came into the main stream of corporate design in the 1990s, popularized by companies like IDEO in California. It is a specifically human-centered design approach, with the aim of determining what is technologically and economically viable within the constraints of an end user's environment. Many companies have used this method to define new products, processes, services and technologies. Steps vary between various groups, but they generally include the following: Scope, Research, Synthesis, Ideation, Prototype, Validation and Build.

In the context of SORMAS the Design Thinking approach was particularly critical in taking different dimension into account, such as (a) the needs of health officers in the field in Africa and their respective training background and working conditions, (b) the individual characteristics of each disease with respect to diagnosis, transmission, case management requirements etc., (c) international and national legal and administrative structures and standards that needed to be adhered to, and, last but not least, (d) the ambition to generate the most possible synergies between collecting information, initiation proper response and supervising the success of the response. Numerous 1-day sessions took place in Germany and in Nigeria, partly connected via teleconferencing system. These were complemented by week long workshops in Germany. All parties were involved in these sessions including teams from Nigeria as well as each of the research institutes mentioned previously. Subgroups were established to work on processes required to capture data within the structures of WHO guidelines. A technology subgroup, both mobile and platform, was formed to take various ideas, decide on what might work, and then use prototyping to see how they integrated business processes developed by the other teams. Weekly international calls were conducted to track progress and determine if and where changes needed to occur. A more detailed discussion on Design Thinking can be found in the chapter '*Creating a Market Analytics Tool That Marketers LOVE to Use—A Case of Digital Transformation at Beiersdorf*'.

4.2 Processes

During the Design Thinking sessions, several processes were developed, leveraging previous in-field experience, standard WHO procedures and the experience of epidemiologists, clinicians and government staff. The group started by detailing processes related to Ebola. Figure 1 shows a high-level description of such a process. Processes were detailed based on Personas developed in the Design Thinking sessions. Personas are representations of a target user or customer the team can more easily identify with when creating a solution (see Fig. 2). Persona teams were described based on functions: 'Rumor and Informant Management', 'Surveillance Management', 'Case Management' and 'Contact Management'. Each team had a supervisor managing tasks across multiple officers who were in the field. This allowed supervisors to level workloads across these officers in case some of these had too much work to do or geographical distance to cover or, as it happened in some cases, come down with the disease themselves.

Primary functions were: identifying potential cases, understanding who else might have come in contact with that potential case, daily monitoring and subsequent confirmation of cases with movement of that case into isolation centers. Coordination across all responsible entities was key in an effort to be as efficient as possible while containing the outbreak. This needed to occur not only within the team, but also across multiple areas of government responsible for the matching of decontamination teams, isolation hospitals, temporary shelters for arriving medical and support staff, and supplies needed to support the additional staff. Capturing data as close to the source as possible was essential not only to contain the outbreak but to improve the efficiency of coordinating a multinational response. Detailed workflows based on the experience in the field are paramount for such an approach.

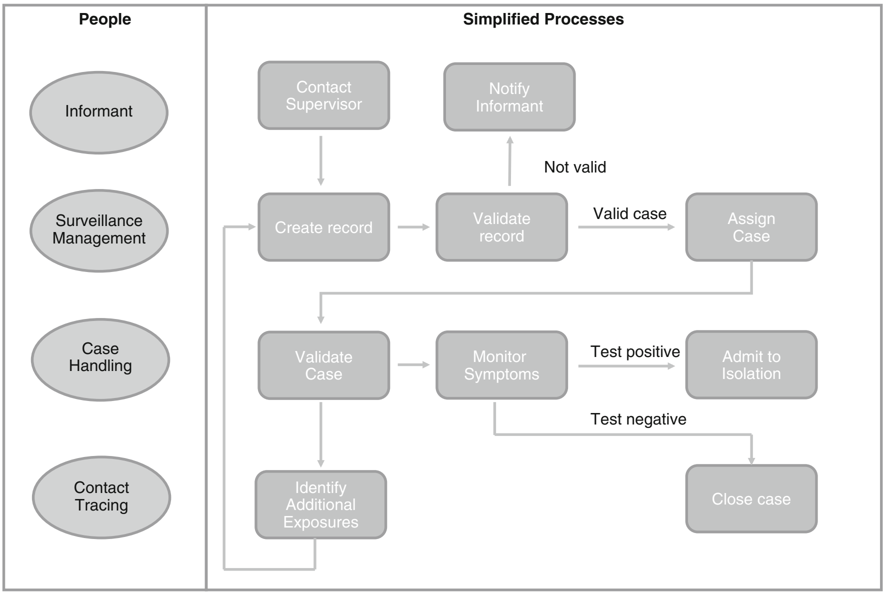

Fig. 1 Process flow for Ebola as developed with the SORMAS team (*Source*: SAP)

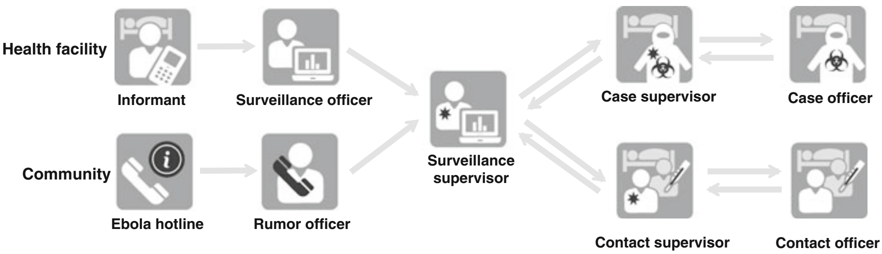

Fig. 2 Personas of SORMAS and their relationships (*Source*: Helmholtz Centre for Infection Research)

Initially, only a process flow that was to track the spread of Ebola was considered. This involved mapping out information flows between individuals and entities. The process was set into motion when there was information about a potentially infected person. To effectively identify a person, several pieces of information were required: Name, location, observed symptoms, as well as the name of an informant—this would then start the process. All this information is important because it allows teams to go back to a location and begin interviewing others who may have been there at the same time and come in contact with the suspected person. Anyone, ranging from a citizen to a doctor, could be an informant. Once the rumor was recorded a ‘Surveillance Supervisor’ validated it and assigned a ‘Case Supervisor’ who in turn assigned a ‘Case Officer’ to manage confirmed infections. If the person was suspected of being infected, without there being a confirmation, the surveillance supervisor would assign the person to a 'Contact Supervisor' who would then be assigned a 'Contact Officer' to monitor symptoms during the incubation period on a daily basis. Supervisors were necessary as they were responsible for Local Government Areas (LGA) within each state and had several officers working for them. The process allowed supervisors to manage the workload of each officer on a daily basis and to provide flexibility throughout the entire tracking and management process as an outbreak developed.

In addition to developing processes for tracking the spread of Ebola, the team developed process flows for three additional diseases to further validate the approach. These were: cholera, measles and H5N1, avian flu. For each disease the processes had to be modified and expanded. To begin with, incubation periods were different, Ebola has one of 21 days, whereas measles takes 7–18 to develop, cholera, on the other hand, needs just between a few hours to 3 days, H5N1 has an incubation period of 2–17 days. Other factors to take into account were the additional ministries or departments needing consideration. Cholera, being water borne, required an inclusion of the ministry of environment and environmental sanitation procedures. Avian flu required that the ministry of animal health be worked into the processes, connecting issues of animal health and that of humans. SORMAS was built to provide access to several additional ministries or departments as the platform expanded to encompass additional diseases.

4.3 Architecture

SORMAS endeavored to use information technology to mitigate the manual processes and time delays noted previously. Access to mobile phones across the globe has increased to a point where there are now more devices with SIM cards than there are people. Most medical members in the field have access to basic cell phones and increasingly to smart phones. Integrating health interventions, such as outbreaks, and using state of the art technologies was important to the POC. The advancement of this technology brought contact management closer to the patient than ever before. Medical staff can now report suspected or confirmed cases directly and quickly to government officials who can then respond much faster than ever before. It also allows for the reduction of touch points in the process of moving data from field workers to headquarters and beyond as there is no more collecting and compiling of worksheets to be transcribed and transported to a central facility.

To support these requirements, and several others not listed here, SAP has leveraged technologies with trusted capabilities. SAP HANA® software was used for the backbone platform where the database and solution was developed, coded, and run. Mobile devices ran using custom programming through Sybase® Mobile Platform. SAP HANA Studio and SAP Lumira® provided analytics capabilities. Figure 3 provides an overview of the solution.

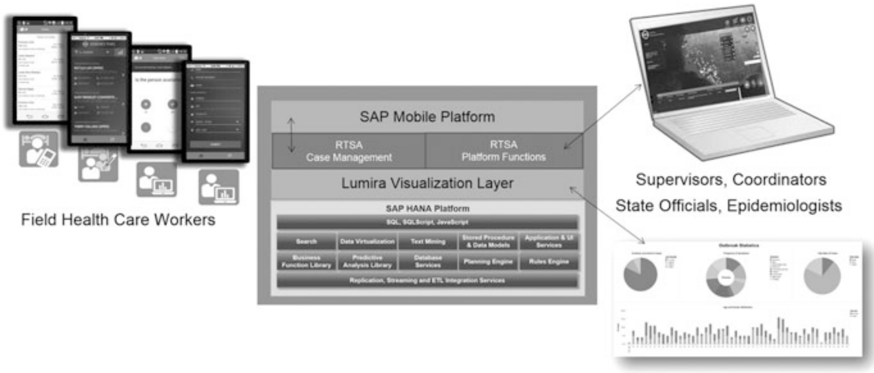

Fig. 3 SORMAS architecture

SAP HANA is a platform for transactional and analytical processing using in-memory data store technology developed by SAP. It is a real-time architecture that integrates application, processing, integration and quality and database services into one platform. By using this integrated platform, developers did not have to concern themselves with building and testing interfaces between multiple software packages as they are all already integrated and part of the platform. This saved considerable time and expense enabling short development cycles. The POC was remotely hosted in SAP's data center in Rot, Germany so that there would be no support requirements placed on the field team in Nigeria during the testing period. Developers and support staff monitored the platform remotely and provided response to any issues arising during the POC.

SORMAS also took into account the data model used in the Epi info schema for hemorrhagic fevers created by the Centers for Disease Control and Prevention (CDC) (CDC 2015a) and followed rigorously data standards of the WHO defined Integrated Disease Surveillance and Response Systems (IDSR) used as the standard for capturing epidemiological data especially in West Africa. This allows for easy data transfer to other agencies around the world reducing time for data transformation and loading.

4.4 Mobile Applications

Field staff members were equipped with mobile smart phones to record rumors and assessments of suspected cases as well as manage contacts and cases as they occurred. Applications written for the contact officer by HPI and rumor and 'Surveillance Officers' by SAP allowed each member of the field staff to perform patient assessments, identify additional people suspected of coming in contact with and to manage daily tasks of the officers (see Fig. 4).

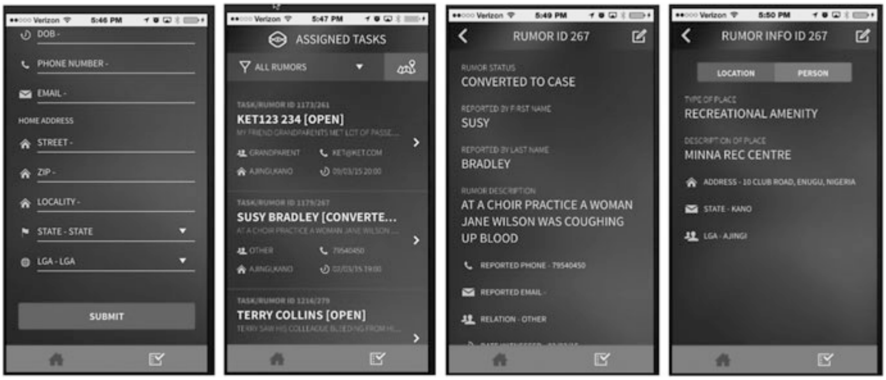

Fig. 4 Surveillance Officer mobile application identifying daily tasks, interviewing and data collection while face-to-face with a suspected case (*Source*: SORMAS Surveillance Officer screenshots)

'Rumor Officers' were contacted by any number of people, ranging from regular citizens to medical staff in clinics or hospitals. Mobile application recorded relevant information including the location of the suspected person at the time. This is important because the teams must return to that place to start interviewing others who may have been there at the same time and may have come into contact with the possible source of infection. The job of surveillance officers was to track down and identify these people for further evaluation. Contact officers had suspected cases assigned to them to monitor on a daily basis for the entire incubation period for that particular disease until the person was either declared to be a case or to be free of the disease. Each one of these mobile applications sent data immediately to the SORMAS platform where it was saved. Also included was the ability to locally store data whenever a cellular network was not available so as not to slow down the work of field staff. When the officer is in range of a cellular network their phones would synchronize to the platform, uploading saved data and downloading updated tasks.

The need to be mobile is important, not only to be able to work in the field, but also to track the progression of a disease in real-time throughout a geographic area as data became available to the platform and supervisors. Decisions could then be made to reassign tasks, move resources into areas not being served and to understand more clearly where the disease was making inroads.

4.5 Test Development

SORMAS was piloted in two states in Nigeria, Oyo State in the South and Kano State in the North (see Fig. 5). These states were chosen because they had clinicians, physicians, epidemiologists and government staff willing to participate, to be

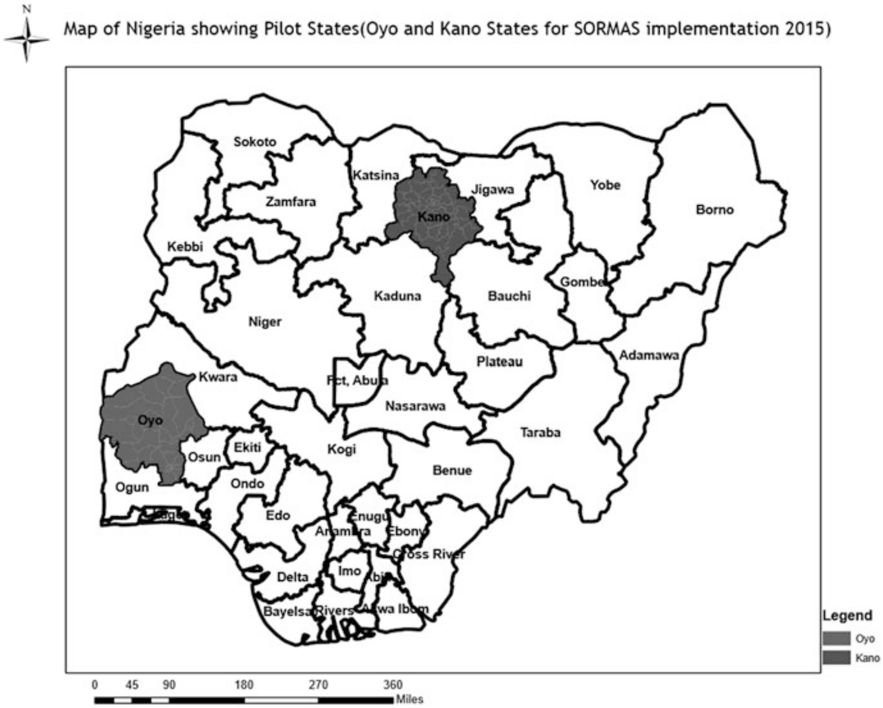

Fig. 5 Map of Nigeria showing pilot State Oyo and Kano (*Source*: Created by D. Tom-Aba, NFELTP)

trained and also to accept the dual workload of recording diseases during the POC. Four urban districts and four rural districts were also selected, as were two private and two public hospitals from each district for additional diversity.

These states were chosen mainly because of the outbreak of H5N1 in Kano state at a time before the POC and the recurrent outbreaks of cholera in Oyo state. It was important to have a live site with these kinds of outbreaks to test SORMAS.

As Nigeria was declared to be free of Ebola infections on 20 October 2014 and the POC started in June of 2015, the team decided to develop test cases simulating an outbreak. Due to the sensitivity of the word Ebola, the term ‘Exercise Disease’ was used during the testing period.

To develop robust test cases the team created a series of instructions for officers to enter data at specific times and on specific dates. In summary, the following data was created to test SORMAS: 550 infected persons, 785 others with symptoms caused by other diseases, in 6400 different locations allowing for some travel between locations to simulate population movements, 489 transmissions in 42 different chains creating 425,994 contacts during the test period.

The platform also allowed views of data (see Fig. 6) entered by field staff for supervisors and government officials’ insight to where an outbreak was, offering information on whether it was growing and on how fast it was spreading. It also

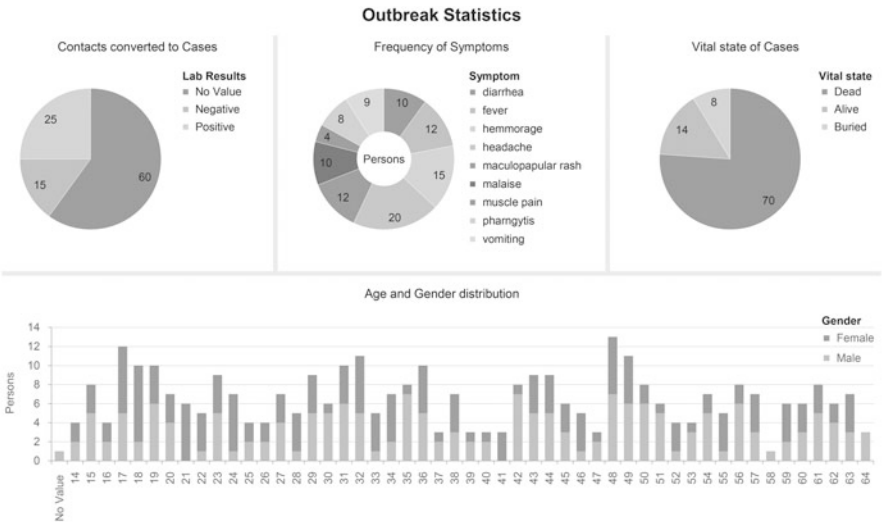

Fig. 6 Analytic dashboard of cases and outcomes (*Source*: SAP)

allowed them to make focused decisions on where to employ scarce resources. Lastly, active cases of cholera, measles and H5N1 were recorded as they occurred, i.e., real cases.

4.6 *Training*

During SORMAS training, introducing a software to people who had different backgrounds or experience in using smart phones was quite challenging but not insurmountable. Training sessions began by asking questions about the familiarity with mobile and smart phones using a ‘pre-training questionnaire’ to assess competency before beginning.

Training on the apps and platform consisted of two sessions over a period of 2 days in each state where the project overview was explained; it also consisted of hands-on access to each of the Personas in SORMAS. Supervisors worked with the platform assigning tasks to field staff, and officers entered training data through mobile phone apps in an effort to walk through each of the functions.

There was a period before official training began, to determine if materials, technology, applications and platform were ready. Once issues were defined and corrected, official training was conducted.

5 Results Achieved

Prior to the POC with SORMAS, health facilities reported their data mostly by first recording the information in hard copy forms which are later centrally transferred to a spreadsheet, leading to many days and weeks delay before data is available. Furthermore, most systems do not provide a systematic, feedback mechanism of actions to be taken by field staff, nor active management or monitoring of those actions. SORMAS closes the gap by capturing all relevant data for all cases at the point of contact, resulting in accurate and timely data being available to those making decisions, reducing that time from days or weeks to real time (see Table 1).

During the POC, a subset of team members went into the field allowing direct interaction with the users of SORMAS. While systematic quantitative analysis is still pending, direct observation in the field showed that even elderly health officers with limited training did not show any hesitation to use smartphone for data entry and documentation. Informal feedback on site also indicated that the officers working in the peripheral health facilities as well as local health departments immediately identified the potential improvement that introduction of a system like SORMAS would provide. The virtual outbreak situation performed during the POC to test the capacity of handling outbreak management processes showed that an additional burden of work and responsibility was required of surveillance supervisors in particular. This is not an artefact introduced by SORMAS. On the contrary, the fact that all these tasks remained in SORMAS showed that data was readily available whereas under traditional communication conditions they would have mostly gotten lost.

Table 1 Comparison of results before and after the SORMAS initiative

Indicators	BEFORE	AFTER
Media breaches/ errors in transmission	e.g., case count from hand written tables to be transferred manually into excel sheets	Case entry digitalized upon first entry
Comprehensiveness of data	Cases identified in health facility notified very limited additional demographic variables via SMS or phone to next level	All retrievable demographic and clinical data digitally transmitted
Timeliness	Initial notification followed by health department staff visiting personally the health facility to fill completed IDSR form	All IDSR form requirements can be directly entered without awaiting health department staff to appear
Data validity	Incorrect demographics or contact details of contact person would lead to loss to follow up	Corrections of contact details can be executed on the spot
Connectivity across administrative boundaries	Hierarchical, mostly papers based information exchange would lead to loss to follow up, if contact persons would move to another LGA or state data was lost	Immediate possibility for surveillance supervisor to reassign a case follow up task to another LGA/state assures follow up of task

Additionally, testing such feedback process flows within a POC proved to be quite complex, as it was based on a virtual outbreak scenario. This complexity challenged the scope of the POC. However, the POC in Nigeria showed that outbreak data could be transmitted from the field staff to the supervisors and they in turn were able to turn this information into specific tasks to give to respective teams in the field. These teams were then able to respond to those tasks and report back. Therefore SORMAS fully met the expectations of the POC with respect to the ability of supporting a complex management process for outbreak containment measures. Within <7 months SORMAS was developed and piloted for four very different infectious pathogens of high public health importance with successful results.

While numerous tools are being developed that use mobile technology to address the need for more flexible and rapid information exchange in disease control, SORMAS is one of the very few that implements a truly multidirectional and interactive process flow designed from the perspective of the public health officers in the field:

- Subject matter experts and future users actively contributed to the concept and design from the very first stage of its development.
- National administrative procedures, international health regulations and other standards widely established within the public health community (e.g., Epi information) have been incorporated.
- SORMAS is, first and foremost, a task management tool, which also includes the functionalities of surveillance.

6 Conclusion and Key Learnings

The development of SORMAS arose in the context of a dramatic international public health emergency and thus did not follow conventional organizational structures, process sequences and time frames. Essentially, much of what would normally be done sequentially over longer periods of time was performed in parallel, requiring a more rapid development approach. This introduced complexity but also fostered improvisation during the project. As with any project, with more time and funding, the team could have added more functionality while reducing complexity. Even so, there were areas that can be taken into consideration on subsequent projects where time, resources and funding are short.

For example, in this case, some users had not used a smart phone application ever before while others used only second generation cellular phones. It was necessary to think through this issue and determine what impact it would have on training and operations once in the field. In addition, given the remoteness of some locations, thinking through how the solution work when the network was down or there was no connection available at all. Lastly, mobile phones were owned by the government for work purposes. Personal use of these phones impacted data charges; therefore another layer of training and tracking was needed.

Design issues needed to be thought through as cultural sensitivity was attached to certain symbols, icons and colors, font sizes. Having process, coding and user interface developers from countries outside Nigeria resulted in some views that could have been contrary to a solution being successful. Language support also required consideration; who selected languages which were to be included. Functionalities that originally were taken for granted may turn out to be unfeasible for reasons of practicality. What worked in one state did not work so well in another due to differences in experience levels and existing processes. Regional and country differences accentuate the need to validate processes. Talking through each step is required to not only understand how this impacts daily work but to also see where improvements can be realized.

Within the context of many solutions there are scientific requirements which must not be overruled by the users' desires or by the programmers' task to minimize complexity with a system. Simplifying the logic of a process may be necessary, yet it needs to be completed by the subject matter experts. In addition, clearly defined nomenclature for the specific topic must be adhered to when building a solution. While the user comes first, subject matter expertise must have veto rights. Given that outbreaks can occur rapidly, clear data collection and reporting protocols must be maintained in order to manage resources and patient viability.

In this context the following lessons would have to be taken into account, if involvement in a similar project again became necessary:

1. *User first*. Spend a considerable amount of time involving local users and their needs during the whole development process. This generally requires patience and education as users do not readily express their needs in ways IT experts can easily translate into code.
2. *Do not underestimate design*. User interface design and the workflow have an important impact on the success of the tool, even in a POC phase. If such issues are neglected and postponed to the later product phase, failure and lack of acceptability in the POC may result in the production phase not even being initiated.
3. *Subject matter expertise*. While local users understand their needs and working environments best, they may not be aware of the non-negotiable biological, medical or epidemiological pre-requisites that require adherence in order to produce reliable and actionable data.
4. *Diversity is key*. The POC was conducted in two very different States in Nigeria, included both urban and rural hospitals, with physicians and government staff that had varying experience with smart phone based applications. This diversity highlighted differences in engagement, responses and acceptance of the proposed solution.
5. *Do not take anything for granted*. Information on the flow of a process, an action within the system, predicted outcomes, or on how certain information can be

retrieved must be validated and re-validated, tested and re-tested to match expectations with results to result in a successful solution.

In conclusion, SORMAS is a formidable example of transformation through technology, design, co-innovation among multidisciplinary, and international public private partnerships. If systemically established as a standard disease surveillance and control tool, SORMAS may become one of the most convincing examples of how information technology can save lives, especially in areas of the world with an irregular technological infrastructure.

Key Learnings

- Within the last several years the world has experienced outbreaks of infectious diseases across geographies in magnitudes of size and speed rarely seen before. Governments have been investigating ways to mitigate, control and reduce spreading of diseases, such as the Ebola outbreak.
- Mobile-based and real-time digital technologies can positively contribute to managing infections at their source and identifying infections early in their cycle to contain and restrict them from becoming an outbreak.
- The Surveillance Outbreak Response Management and Analysis System—SORMAS allows to monitor suspected cases in an effort to control the disease from spreading.
- This chapter demonstrated how digital technology and innovative development approaches can lead to protection of human lives, especially in countries where infrastructure and access to resources will remain a challenge for the foreseeable future.

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David Moyer leads the Services Portfolio Management team for Public Sector and Healthcare. His team built the SORMAS platform and the Surveillance and Rumor Officer mobile applications, and provided support during the POC in Nigeria. He has built and packaged solutions to support the industry while leveraging technology to improve the way governments and healthcare institutions better serve their constituents. David has a Bachelor degree from the Wharton school, University of Pennsylvania.

Daniel Tom-Aba was previously a senior data manager at African Field Epidemiology Network and Nigeria Field Epidemiology Laboratory Training Programme (NFELTP). Prior to that, he was the data manager for the Polio Emergency Operations Center for the Polio Response Effort in Nigeria, working with the US Centers for Disease Control and Prevention through the National Stop Transmission of Polio (N-STOP) and data manager for the Ebola Emergency Operations Center during the 2014 Ebola Outbreak in Nigeria.

Shuchi Sharma has worked in healthcare, management consulting, and software for over 20 years. She has held senior leadership positions in management consulting, professional service, and software firms in both Europe and the US. Shuchi has a master's degree in Public Health Management and Policy from the University of Michigan, School of Public Health.

Gérard Krause is a physician and an epidemiologist. He is chair for infectious disease epidemiology at the Hannover Medical School and the founder of the epidemiology department at Helmholtz Centre for Infection Research in Braunschweig, Germany. He is project lead of SORMAS (Surveillance, Outbreak Response Management and Analysis System) piloted in Nigeria during the West African Ebola Outbreak 2015.

A Journey of Digital Innovation and Transformation: The Case of Hilti

Jan vom Brocke, Maria Fay, Theresa Schmiedel, Martin Petry, Felix Krause, and Tim Teinzer

Abstract The Hilti Corporation sets an example how to leverage digital innovation. Hilti has come a long way since its founder, Martin Hilti, envisioned in 1951 the importance of global information systems in facilitating global business. Hilti has made two attempts to harmonize process and data, and since 2006 has successfully run on a single-instance SAP® solution, handling 200,000 customer contacts every day. Since then, the company has undertaken multiple enterprise-wide initiatives to benefit from globally available data and systems, to become more consistent in running day-to-day operations, and to make it possible to realize innovation opportunities that the digital world presents.

Over the course of 15 years of transformation, this digital journey has changed the day-to-day work of thousands of employees and the management and service processes for customers worldwide. Today, Hilti's information systems infrastructure facilitates innovations in digital quality and speed using the latest technology trends, such as cloud, mobile, the Internet of Things, and Big Data analytics. As a digital enterprise, Hilti excels at innovation and transformation. A positive company dynamic in terms of market share and financial performance has proven the digital journey on which Hilti has embarked to be effective, enabling Hilti to continue creating and harvesting new opportunities.

J. vom Brocke (✉) • T. Schmiedel
University of Liechtenstein, Vaduz, Liechtenstein
e-mail: jan.vom.brocke@uni.li; theresa.schmiedel@uni.li

M. Fay
University of Liechtenstein, Vaduz, Liechtenstein

SAP (Schweiz) AG, Regensdorf, Switzerland
e-mail: maria.fay@sap.com

M. Petry • F. Krause
Hilti AG, Schaan, Liechtenstein
e-mail: martin.petry@hilti.com; felix.krause@hilti.com

T. Teinzer
SAP Deutschland SE & Co. KG, Walldorf, Germany
e-mail: tim.teinzer@sap.com

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This case study reports on the key activities, challenges, and success factors of each phase of Hilti's digital journey and discusses the lessons learned and their implications for the company.

1 Introduction

Hilti is one of the world's largest players in the construction and building-maintenance industry, manufacturing tools and providing services to construction professionals around the world. Its headquarters in Liechtenstein, the company has more than 22,000 employees worldwide serving its customers in more than 120 countries (as of 2015). Hilti operates production facilities and R&D centers and is heavily involved in diverse technology partnerships. Hilti's strategic foundation builds on a strong, "caring and performance-oriented culture," while serving the core company purpose of "passionately creat[ing] enthusiastic customers and build[ing] a better future" (Hilti n.d.).

Following these principles, the company focuses on product and service differentiation, direct customer relationships, operational excellence, and high-performing global teams. Hilti is not only a production company but also a service company, with most of its employees involved in direct sales. Therefore, a seamless integration of all sales channels and, in a larger scale, of all technological and organizational elements is key to achieving operational and customer-relationship excellence.

Hilti has worked for years on coordinating and standardizing data and processes, and based on its global reach, has benefitted from the full potential of digital transformation. Hilti introduced a series of major initiatives to increase its performance over time and make a smooth transition from a company with locally optimized business solutions to one with mobile and real-time business solutions and advanced analytics tools in place, ensuring continuous improvement, innovation, and value creation. However, new technology-enabled opportunities do not create value straight away but require leveraging holistically the potential of digital technologies to support process innovation.

This case study takes the reader on the digital innovation and transformation journey that helped Hilti redefine business processes and work, become a globally integrated enterprise, and achieve operational and customer-service excellence.

2 The Journey

Digitalization per se was not Hilti's goal when it began its digital-transformation journey. Operational excellence, customer satisfaction and the ability to serve its customers' needs (which are now digital or digitally enabled) were at the core of the company's vision when it undertook the global integration of its processes and data.

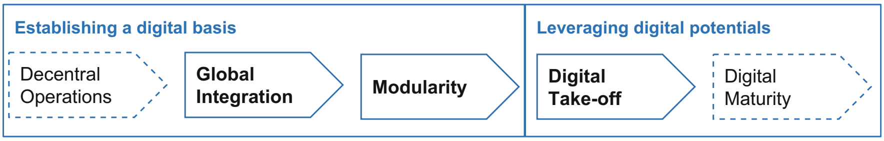

Fig. 1 Hilti's journey to becoming a digital enterprise

Given the fundamental nature of the change, Hilti's transformation was 'radical' in scope (Safrudin et al. 2014); it went from the business's transforming IT to IT's transforming the business with new digital innovations, starting from local business integration, moving toward global IT standardization, achieving IT agility, and finally establishing balance (IT, business, employees and customers), that supports digital innovation.

On its transformation journey toward becoming a digital enterprise, Hilti moved through several phases, first establishing a digital basis and then leveraging digital potential, as Fig. 1 illustrates.

To establish a digital basis, a company must first move out of the chaotic phase, with only locally optimized solutions. As long as enterprise's processes, systems, and structures remain in silos and cannot be integrated, the company's transformation journey has little chance of success. Therefore, efforts are undertaken in the 'Global Integration' phase to establish stable and reliable enterprise-wide processes and common data structures that are fundamental for the company. These processes and structures allow a certain degree of flexibility and agility in the 'Modularity' phase, after which the company can start leveraging digital potential. The 'Digital Take-off' phase occurs when the previous innovation and transformation efforts result in the creation of the new digital offerings. Finally, the 'Digital Maturity' phase occurs when leveraging digital potential becomes daily business and is a fully integrated part of the enterprise's business model.

Next, we look into each of these phases in detail in order to describe Hilti's journey to digital innovation and transformation.

2.1 *Decentral Operations*

When Hilti embarked on its digital journey in 2000, the company's organization, processes, and IT infrastructure were highly diverse and heterogeneous, with silos between its components. This lack of integration always represents a challenge, but even more so in organizations that are undergoing digital transformations. In the digital age, customers expect a single point of contact and consistent behavior across all communication channels as a part of an omni-channel concept. While silos could be hidden or bypassed in pre-digital times, these weaknesses are transparent in the digital age, making organizations more vulnerable to competition. The main challenge that Hilti faced was in the slow and sometime inconsistent ways in which initiatives in pursuit of operational excellence were implemented.

Diversity in the information systems landscape is reflected in the heterogeneity of practices that prevent an organization from acting as one global company. The more global a business becomes, the more important it is to establish standards to ensure unified customer experiences around the world. Though heterogeneity of values and practices comes with the danger of hindering organizations from taking action, it can also have positive effects, as it enables rich inputs and has positive motivational effects.

It takes courage and strong vision to break down silos. In the case of Hilti, the founder, Martin Hilti, supported by a strong and committed leadership team, acknowledged the need for global standards at an early stage of the company's development. His view was not to standardize for the sake of standardizing, to digitize for the sake of digitalization, or to follow blindly established practices or the latest trends. Instead, he sought to achieve global integration and adhere to standards for the sake of business opportunities that may seem hard to quantify in the beginning, although a clear picture of what they mean in qualitative and strategic terms is important.

2.2 *Global Integration*

At Hilti, the basis of the transformation was established by putting the global processes, systems, and data in place to achieve global integration. These results were strengthened by the cultural and organizational transformation that established support for the transformation among employees and ensured the necessary changes in their thinking and behavior.

2.2.1 Establishing the Basis for Transformation: Global Processes and Data

Hilti started the journey with the globalization of its IT functions by introducing common data structures, system landscapes, and processes to eliminate silos and improve decision support, operational efficiency, and customer experiences. The company designed and executed the Global Processes and Data (GPD) program, which contributed to re-imagining the IT organization [e.g., by establishing the role of regional infrastructure managers (RIM) as managing an onsite IT team and reporting back to the central IT team at the headquarters] and put enterprise-wide solutions in place (especially to support globally decentralized sales processes). For instance, Hilti built a global process for CRM that encompassed a 360° customer service, integrated all sales channels, and established a structured, planned sales-management process.

The 'IT Excellence' that the company was developing with the launch of the GPD program required first a comprehensive vision that was aligned with the company's business strategy. The realization of the GPD program started with gaining support for a transformational project, which was accomplished primarily by building awareness that the project was triggered by the need to pursue new opportunities. Having brought all stakeholders on board and ensured their support, Hilti built a project management team for the following project implementation, which involved several hundred employees in the headquarters, plants, and field organizations.

At all stages, the company communicated the program status and vision to all stakeholders, partners, and employees, which helped Hilti to ensure that the long-term impact of the transformation was transparent to all employees and to overcome resistance. Having committed to developing its 'Transformation capability' as a social process dependent on interaction and communication, Hilti made a step toward more effective and efficient change, made possible the creation of an integrated platform, showed the company's understanding of the topic's importance, and demonstrated its persistence in getting the integration right at each step.

In order to implement GPD around the world, Hilti used cross-fertilization, pushing transformation through peers from various sales organizations, who synchronized their efforts and supported each other. Organizing peer visits for the GPD projects helped to ensure synchronization between the organizations and made the learning and sharing process of the ongoing development of the newly established practices more efficient. Hilti also received support by becoming a ramp-up partner of SAP, which gave it dedicated coaches and support for its solutions.

2.2.2 Establishing Employees' Support for Transformation: The 'Cultural Journey'

While the GPD program has contributed to establishing enterprise-wide processes and solutions, Hilti decided to accompany it with a 'cultural journey'. Back in the 1980s and 1990s, the company had made an attempt to standardize IT systems, but it focused on technical changes and did not involve data and process flow, as well as the social component. Therefore, a second attempt was necessary.

Lyytinen and Newman (2008) advocated for a socio-technical balance and stability that ensure positive performance, achieved by establishing, "relationships within and between the system components and its environment" (p. 594). At Hilti, such socio-technical integration was realized by creating an integrated platform and infrastructure while it adopted a 'global' culture. Shared corporate values are essential in building a successful IT strategy. Communicating honestly and clearly and setting measurable targets for processes and activities play an important role. In Hilti's case, this approach helped to build a team that spoke a common language at both the management and the employee levels and to set clear and shared principles for all stakeholders involved.

Brüggemann and Riehle (2013) noted that the, "basic condition of successful IT innovations and transformations lies in understanding the implementation as a social process" (p. 215). They pointed out that this process relies on interaction and motivation, which is why the actions taken by Hilti to focus on commonly shared values and to form a holistic corporate culture supporting the change were so important. As employees represent one of the key competitive advantages of any company, establishing an open, knowledge-sharing culture was an important element in ensuring support for the change. Hilti developed a shared corporate culture and values step by step through design, realization, and further support of the socio-technical integration. One of the biggest challenges was overcoming the lack of awareness of the company's culture and vision.

The globally shared corporate values have become an essential element of the new IT strategy, even reflected in the IT Core Purpose Statement—"We passionately enable business excellence through global IT solutions,"—which was created to be aligned with the enterprise-wide Core Purpose Statement: "We passionately create enthusiastic customers and build a better future" vom Brocke and Rosemann (2014, p. 703).

As a part of the integration journey, Hilti introduced several processes defined on the corporate level: product portfolio management, market reach, supply chain management, and professional services. The outcomes of these processes were monitored for performance and contribution to the corporate values and objectives. The project team also pointed out the quick wins achieved along the way in order to ensure that the project stayed on track and the results were visible. Doing so strengthened the project's reputation among stakeholders and helped to build their support.

Key Takeaways from the Global Integration Phase:

- Integrate a *strong vision* with *smooth implementation*. Early prototypes and dry runs ensure that the final result corresponds to the requirements and achieves the planned goals while minimizing risk and avoiding unexpected incidents. Only when the goals are clear, and continuous development and improvement of the final result takes place will the structure of multiple integrated elements bring the expected results.
- Earn *credibility* by delivering *tangible results*. A step-by-step approach presented in a simple but comprehensive roadmap and roll-out plan with clear 'quick wins' achieved and communicated ensures project visibility and acceptance. The more ambitious the final goal, the more important it is to be persistent in achieving what is planned. The Hilti case shows that a strategy of delivering tangible results helps to earn credibility from the stakeholders and to build their trust in and support of the ambitious project. A professional and dedicated project team that is committed to and capable of conducting the necessary changes plays a central role in achieving these goals.
- Establish *peer-to-peer knowledge transfer*. The Hilti case demonstrates that peer-to-peer knowledge transfer facilitates the global integration process while taking advantage of available knowledge and skills. Peer visits in the GPD projects helped to synchronize the work between the organizations and to make the learning and sharing process more efficient as new practices were developed.

2.3 Modularity

In this phase of the journey, Hilti became more adaptive by exploiting its existing assets and capabilities while at the same time exploring new ideas, opportunities, and technologies. The company chose to pursue the opportunities of business modularity and define areas of business that required integration—covering standard business processes with standard software—instead of those where Hilti could be more agile in experimenting with new technologies—that is, add-ons that cover specific business needs.

The Hilti CIO and his team developed the 'solid core and flexible boundary' concept which provides a framework for 'controlled flexibility'. Controlled flexibility refers to establishing an optimal balance between implementation of fully integrated standard software to cover standard business processes ('solid core') and agility with add-on technology that covers specific business needs ('flexible boundary') as an architecture paradigm within a delivery model as a key element of the IT strategy. Whenever there is a need for fully integrating data, 'solid core' is the choice. On the other hand, solutions that require a lower level of integration should be the adopted in a 'flexible boundary' delivery model. Importantly, the interaction between the two types of solutions is established via standard interfaces to avoid going back to silos.

The concepts of solid core and flexible boundary brought order to modularity, since they conceptually distinguish IT core services that are more mature from IT services that explore innovation potentials and are managed according to more flexible principles. To achieve operational excellence, then, Hilti leveraged the potential of new technologies while keeping all crucial areas of business under control.

With constant competitive market pressure, organizations seek to excel in both operations (continuous improvement) and transformations (process innovation) (Schmiedel et al. 2015). Tushman and O'Reilly (1996) confirmed this dual approach in introducing the organizational ambidexterity theory as "the ability to simultaneously pursue both incremental and discontinuous innovation [. . .] hosting multiple contradictory structures, processes, and cultures within the same firm" (p. 24). In laying out the foundations for this theory, March (1991) noted that the key adaptive challenge for the companies is to develop the ability both to *exploit* their existing assets and capabilities and to *explore* for opportunities, new technologies, and markets. The focus of exploitation is on efficiency, control, and variance reduction, while the focus of exploration is on flexibility, autonomy, and experimentation. While exploitation can help to ensure *current viability*, exploration can help to ensure *future viability*.

With its concept of solid core and flexible boundary, Hilti was able to focus on both exploitation and exploration. *Business modularity* allowed the company to differentiate between high-standardization areas of business like accounting and low-standardization areas like loyalty programs, where deviation from a standard is often necessary. To support such modularity with information and solutions, Hilti introduced the hub structure, where regional hubs supported local hub units with training and operations (logistics, finance, HR) to leverage the available capacity and knowledge pool. For certain projects, IT could then partner with businesses at the hub or regional level.

Integrated processes provide a solid foundation for operational excellence and digital transformation; still, as Hilti's example shows, organizations need sufficient flexibility and agility to identify and benefit from emerging business opportunities. By reaching higher on the scale of operational excellence, the company can unleash its potential to innovate, and trigger a 'Digital Take-Off'.

Key Takeaways from the Modularity Phase:

- Introduce a *solid core and flexible boundary* principle. Differentiate between business that requires more integration and business that could be more agile and experiment with new technologies in its operations. This differentiation enables the organization to achieve both agility and stability, supporting the idea of *controlled flexibility*.
- *Balance between complexity* (resulting from high levels of integration and automation) and *simplicity* (involving manual effort). The 'one size fits all' approach in Hilti's case was replaced by the choice among solutions (e.g., simpler ones for smaller sales subsidiaries and more complex ones for large plants or headquarters).
- Allow for *context-specific governance structures*, depending on the business area's nature and strategic role. The solid core and flexible boundary principle enabled Hilti to establish the hub structure and manage it efficiently. Other organizations may have other principles and approaches, but the essential element remains: to decide in what area each business type applies and to implement a set of different, well-defined management approaches for those areas.

2.4 Digital Take-Off

Hilti considered multiple technologies that could have the biggest impact on the market and the company's competitive advantages. One of the examples of digital transformation in the construction industry is Building Information Modeling (BIM) software, which provides new functionality for the planning and management of construction projects. BIM supports digital visualizations of the entire building, as well as separate elements (such as the building equipment), and links it to time constraints and cost-related information. In this environment Hilti and other market players are challenged to rethink their business models, and here Hilti's strong IT-enabled innovation capabilities are important assets.

As a part of 'opportunity discovery' various technologies (like IoT and Big Data) were examined for, among other factors, their disruptive potential. As an example of such opportunity-identification activities, Hilti conducted workshops with students and colleagues from the University of Liechtenstein to reveal the business potential of in-memory technology at an early stage in its development. As a result, Hilti envisioned the creation of a multifunctional Sales App that would improve the performance of the sales and support processes that account for a major part of the company's business operations.

Functional affordance theory suggests that technology offers the possibility for action only in relation to specific use cases (Leonardi 2011; Gaver 1991; Seidel et al. 2013). To ensure that the innovation process is business-driven, relevant use cases have to be identified first, as only then one can explore how contemporary digital technology can offer new possibilities for action in such use cases. For many organizations, exploring the use of IT requires a new mindset, because the predominant logic has been on exploitation, rather than exploration (vom Brocke et al. 2015b). In fact, changing this mindset and having differing mindsets (some focused on exploitation and some on exploration) in one organization at the same time is a challenge for a number of companies. Hilti benefited from reaching out to universities around the world, as doing so allowed it to include divergent and innovative thinking, and methods like Design Thinking helped to foster innovativeness (Plattner et al. 2009, 2010; Johansson-Sköldberg et al. 2013).

In the Digital Take-Off phase, which is the stage in which Hilti resides currently, Hilti focuses on establishing three key elements: digital processes, digital offerings, and digital interfaces. Taking a closer look at the three elements of the Digital Take-Off at Hilti shows how the IT function helps to provide the needed technologies and ensures that an effective and efficient operating model is implemented.

The work stream for *digital processes* supports the delivery of services that enable business process and workplace excellence and bring value for all stakeholders. Hilti constantly looks for improvements in the way it works, striving to bring collaboration, reliability, usability, and productivity to the next level. In rethinking how the company works, Hilti builds on its previously created digital basis (global integration and modularity) and focuses on both workplace and business-process solutions. Hilti also strives for device independence in order to be ready for upcoming technologies.

Hilti pays special attention to areas that refer to digital processes. For example, data integration across all channels and the consequent use of analytics help Hilti to provide guided selling solutions and to increase its effectiveness in selling innovations. Establishing the Hilti Cloud helps to enable the agile development and deployment of customer-facing applications. Hilti has also prepared well for its Digital Take-Off, as new solutions are fully device-independent. For example, touch readiness in applications is guaranteed, and mobile Apps run on hybrid devices. This approach supports employees in choosing their preferred devices. The adoption of new devices, such as wearables, can also be realized quickly based on this preparation.

Another dimension of Hilti's digital processes refers to how Hilti brings experts together. Hilti's social media helps to integrate backend experts into sales processes, thereby facilitating customer relationship management. Overall, Hilti considers all kinds of new initiatives (from social media to cloud technologies, from touchscreens for sales forces to virtual desktops) to enable and support digital processes.

(2) The *digital offerings* stream focuses on software and software-based services to support customer offerings and product-related processes. Introducing digital

technologies in such processes might not bring immediate financial value, but it results in valuable strategic benefits and competitive advantages achieved in the mid-term. Among some of the topics that Hilti has been investigating in this context are adaptive tools, layout integration, and asset management (Cousins 2015).

The adaptive tools concept involves multiple elements, from using sensors to detect potential future problems, to the tools ability to adjust the settings depending on a situation, without a person being involved (although the settings can be corrected by an operator). This capability dramatically decreases the standard set-up time for tools and allows for preventive maintenance.

The layout-integration concept refers to the use of data obtained through RFID or a wireless internet connection to trigger a variety of actions or changes in the workpieces' characteristics. Completing multiple operations can now be done without referring to additional guides to define the next steps, which also decreases risk related to human error.

(3) The *digital customer interface* stream concentrates on digital technologies for market reach related to digital interfaces. As a part of product support, Hilti provides its customers with an application for selection, ordering and usage support for the entire Hilti product and application portfolio. This interface facilitates more efficient, productive, fast, and easy communication between customers and Hilti.

One of the many effects of Hilti's IT strategy was that no single technology ever stands alone; instead, the smart combination of technologies, both innovative and conventional, creates affordances in specific use cases (vom Brocke and Rosemann (2014) and supports the organization's 'Innovation Capability' during the Digital Take-Off. Brynjolfsson and McAfee (2014) described the recombination of technological inventions as one of the main drivers of digital transformation in the second machine age. They reflected on the term 'general purpose technology' (GPT) as technologies like steam power and the automobile that radically change how we live, work, and manage our economic activities. Treating information and communications technologies as a GPT enables the continuous reassembly of existing building blocks to yield additional value through recombinant innovation. The authors emphasize the great potential of this combinatorial view of digitization as compared to the traditional perspective that innovations are used up and discarded over time.

Hilti has come a long way in demonstrating its ability to recognize the potential of digital technologies and giving priority to those that are aligned with its strategy. As Safrudin et al. (2015) put it, "innovation capability in digital enterprise refers to the ability [not just] to develop … novel ideas, but to position those ideas into widely used practice that adds value for the end user." Therefore, Hilti eschews the 'nice-to-have' trends in favor of considering each option while staying flexible and proactive enough for fast implementation and learning. Leveraging and configuring the innovation capability is an essential condition and enabler for successful business results in a digital world.

Key Takeaways from the Digital Take-Off Phase:

- Innovate when the *right technology* meets the *right use context*. The Hilti case presents examples of how to identify such use contexts and how to guide innovation toward the most value-creating scenarios for an organization. As functional affordances are rarely provided by a stand-alone technology, finding the right combination of new and established technologies can lead to reach higher levels of innovation.

- Ensure that the innovation process is not technology-*driven*, but technology-*enabled*. The major technology trends provide opportunities to explore the advantages of diverse business and technological options. The Hilti case shows that innovation should not focus on seeking a use for a new technology but on understanding its strengths and weaknesses and considering whether using them is beneficial to one's business.
- *Focus on the strength* of your organization. While considerable flexibility is needed in order to adapt to change, the identity of an organization is key to finding a strong position in new market structures. Successful companies find ways to demonstrate their values in the digital world. Hilti's clear customer focus has been key to identifying value-creating use cases (e.g., the aforementioned Sales App), in which the company could improve how it serves its key purposes. While an ocean of opportunities may arise through digital technologies, the business models that prove successful are those that are in line with existing values. In this regard, embracing digital transformation successfully goes along with re-focusing on the organization's core values and strategies.

2.5 Digital Maturity

Based on the capabilities built earlier, Hilti began its Digital Take-Off, creating digital processes, offerings, and interfaces. The next step will be the Digital Maturity stage, which integrates digital innovations into the business model as part of the company's day-to-day business.

Hilti's journey illustrates how digital capabilities build on each other: global integration enables controlled modularity, which enables the Digital Take-Off, which prepares Digital Maturity. Such an overall transformation is can be successful only if all of these phases are mastered step by step, neglecting none. However, technical and non-technical capabilities may be built up in parallel and in an accelerated way. While deep knowledge regarding contemporary technologies is key, leveraging technologies requires extensive organizational competencies in multiple domains, such as organizational culture, skill development, governance mechanisms, and strategic alignment of related initiatives.

At the previous stage of its digital transformation journey, Hilti focused on three key functions: digital processes, digital offerings, and digital customer interfaces. The company chose digital technologies to be implemented in order to achieve strategic benefits. In 2014, Hilti started a large-scale strategy development process in which the role of IT was re-investigated in all areas of business. It was recognized that the extent to which IT can be used keeps extending, in particular directly into products and services.

Working in the context of constant digital advances, companies must develop their capability to sense the environment, identify needed data, and create a new customer experience, offering not only products but also integrated, digitally enabled services. This transformation capability plays a major role in a company's ability to establish a digital enterprise.

Along with innovation and new opportunities comes system complexity. Therefore, companies must ensure that the right processes are in place to manage this complexity and frame innovation within their socio-technical systems. The Hilti case gives numerous examples of how digital innovation must consider the wider environment of information systems that speeding up a process is backed up by the socio-technical environment so that related processes or people do not become new bottlenecks.

3 Conclusion and Key Learnings

This case shows how a company in the traditional construction industry can transform by adding digital technology throughout the value chain. At Hilti, global integration and modularity provided the basis of a digital transformation, from global data and process harmonization in the beginning to a phase of transformation within Industry 4.0 and the Internet of Things. RFID chips inside tools, preventive maintenance, and advanced asset management are just some examples of the digital technologies from which the company was one of the first to benefit.

However, digital capabilities are highly specific to an organization's context. By going through the phases described above, Hilti built a strong transformation capability, enabling the company to pursue this digital journey. This transformation capability is not limited to technology, but to a very large extent it also embraces organizational structures. The Hilti culture sets the motivation and the mind-set for continuously innovating business through IT (vom Brocke et al. 2010). The Hilti case also shows that a deep understanding of the organization's socio-economic environment is essential if a suitable digitalization strategy is to be developed (vom Brocke et al. 2015a; vom Brocke et al. 2016), as what works for one organization does not necessarily work for another. Aligning both the market dynamics and the strategic positioning an organization's individual DNA plays an important role.

Above all, the Hilti case demonstrates the importance of building digital capabilities in order to master and benefit from digital transformation. Hilti started to build these capabilities long before it became a general trend, and it was through ambitious, ongoing projects that Hilti continuously challenged itself and grew. Hilti's strategy is subject to continuous revision and adaptation to help ensure success.

The transformation that took place at Hilti will never stop, as a truly digital enterprise recognizes the need to succeed by meeting challenges, questioning the status quo, and achieving efficiency and effectiveness by exploring new resources and opportunities and exploiting existing ones.

Key Learnings

- Digital transformation requires a *backbone*.
- The 'digital backbone' is a prerequisite to pursuing future developments. A company's digital strategy can be a façade—rather than a fully implemented architecture (Tumbas et al. 2015)—that shows a concept of the organization in the digital world for employees and customers.
- Digital transformation *should not* be adopted *for its own sake*.
- Digital transformation focuses on meeting customer demands and requirements rather than blindly pursuing the latest trends, but customers expect these digital offerings, so a company that does not offer them loses customers.
- Digital transformation requires *a strategy*. In order to guide and align related actions, digital transformation strategy should outline key objectives, expected developments, and related actions, and it often gives an organization an identity in the digital world.
- Digital strategy implementation requires *courage*. Future market mechanisms are hard to foresee, and there is little guarantee of economic success. During Hilti's multi-year journey, it made courageous decisions that enabled new opportunities for the organization.
- Digital transformation is not a *source* of income but a *means* by which to earn money.
  Customers expect digital offerings to come free of charge, so building digital capabilities should be seen as an investment. That said, the long-term horizon of such investments must be communicated clearly as preparing for a longer-term payoff mostly in *strategic* terms without raising expectations for an immediate payoff in *financial* terms.

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Jan vom Brocke is a professor of information systems, the Hilti Chair of Business Process Management, the Head of the Institute for Information Systems, and Vice President for Research and Innovation at the University of Liechtenstein. An expert in digital innovation and transformation, he has published more than 300 articles and 25 books, including *Business Process Management—Driving Innovation in a Digital World*. Jan vom Brocke is an invited speaker and trusted advisor on digital business for many organizations around the world.

Maria Fay conducts research and leads executive training programs for SAP® Business Transformation Services. She holds a master's degree with honors in business informatics and is pursuing a Ph.D. at the University of Liechtenstein, investigating the business value of advanced analytics. Prior to joining SAP, she worked in a global technology consulting company and a large innovation center. Fay is an alumnus of the HPI School of Design Thinking and a coach in the area of business model innovation.

Theresa Schmiedel is an Assistant Professor at the Hilti Chair of Business Process Management at the University of Liechtenstein. She holds a Ph.D. in business economics from the University of Liechtenstein and a diploma in economics from the University of Hohenheim, Stuttgart, Germany,

which she conducted partially at York University in Toronto, Canada. Her research focuses on social aspects of information systems research, particularly on the interconnection of culture and business process management.

Martin Petry became Hilti's CIO in 2005. He is responsible for Hilti's 400 IT employees based in Switzerland (Buchs SG), US (Tulsa, Oklahoma and Plano, Texas) and Malaysia (Kuala Lumpur). Since 2009 he is also in charge of Hilti's Business Excellence initiatives and EVP. Martin came to Hilti in 1993 and has held various leadership roles in Liechtenstein, Switzerland, Great Britain and Japan. He has developed Hilti's ground-breaking IT Strategy in 2000 and has lead its implementation, in particular Hilti's global SAP implementation cum business transformation project (standard global data structures and business processes supported by a global SAP system with ERP, BI, CRM and SCM which is now being used by 20,000 Hilti employees in more than 50 countries). Recently Martin has initiated various cloud computing/SaaS initiatives at Hilti and he has lead the development of the comprehensive Information Technology at Hilti strategy which is now the foundation of all digital and software initiatives in the Hilti group. Martin earned his Ph.D. in applied mathematics from Georg-August University in Goettingen, Germany.

Felix Krause received his Ph.D. in Business Information Systems Engineering from the Research Center Finance and Information Management (FIM) at the University of Augsburg in 2014. His research focused on the area of analysis and economic valuation of process flexibility. Felix joined Hilti Global IT in 2014 where he is responsible for several projects in the area of Customer Relationship Management (CRM) including the definition of a new CRM Strategy that sets the guidelines for future investments in that area.

Tim Teinzer joined SAP in 2000. As a member of the BTS Global Leadership Team, part of SAP Digital Business Services, he heads the BTS Global Management Office. He has held several consulting positions and has worked on international customer projects. Teinzer holds an MBA degree with focus on business integration and is a lecturer in Business Information Systems at the Cooperative State University Mannheim, Germany.

The Future of Automobility

Tomasz Janasz and Uwe Schneidewind

Abstract A paradigm shift towards 'sustainable mobility' has been proposed in the recent past. This paradigm encompasses three main approaches: efficiency increase, modal shift and reduction of mobility needs. The authors of this chapter focus on the first area by presenting efficiency potentials of innovative mobility concepts which flourish at the frontier of digital technologies, shared mobility patterns and vehicle automation. Not only do they provide an overview of these concepts, but they also make an attempt to innovate and design completely new business models. It is based on the authors' conviction that business model creation and innovation are crucial for a high diffusion of any new technology, as the necessary prerequisite for the industry is to gain profits out of innovative applications.

The contribution at hand showcases current developments in car- and ridesharing by depicting two relevant case studies. Additionally, it provides a description of innovative mobility concepts based on vehicle digitization and automation, along with a review of their possible advantages and disadvantages for the society. Finally, the chapter features five 'ready-for-implementation' business model prototypes for the future of automobility. In doing that the authors bring up novel ideas on how to commercialize and overcome the inefficiencies associated with private car ownership and usage.

[This chapter is based on the outcomes of the doctoral thesis *'Paradigm Shift in Urban Mobility: Towards Factor 10 of Automobility'* (Janasz 2016 forthcoming)].

1 Introduction

What began with the introduction of microprocessors in the 1970s, today is being referred to as the 'Fifth Technological Revolution'. Some recent technological paradigms such as ubiquitous computing, big data, social media or the internet of

T. Janasz (✉)
SAP (Schweiz) AG, Regensdorf, Switzerland
e-mail: t.janasz@sap.com

U. Schneidewind
Wuppertal Institute for Climate, Environment and Energy, Wuppertal, Germany
e-mail: uwe.schneidewind@wupperinst.org

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things imply that the digital era is going into the next disruption wave. It is also indisputable that in recent years this pervasive digitization has induced business innovation processes which have touched upon almost every single sphere of human life. Recently, one further domain has been affected—the system of automobility. This can be justified by the emergence of niche players who aim at disrupting the existing market by providing digital-enabled services in mobility. A case in point is Uber Technologies Inc., the game changing company within the taxi sector.

Automobility refers to the use of cars as the major means of transportation (Urry 2008). Moreover, it is about centering the "society and everyday life around automobiles and their spaces" (Henderson 2006, p. 293). It is thought that it is characterized by severe cracks in its underlying system design. The one side of the coin is the radical unsustainability of cars which is expressed by their substantial contribution to greenhouse gas emissions. The other side is the inefficiency of cars as reflected by their extreme underutilization: an average car remains parked for 90–95 % of each day and once it is moved it often carries only one passenger (Barter 2013). This leads to a considerable consumption of space in urban areas. It has been recognized that, from economic, ecological and social perspectives, the mobility paradigm solely based on private car ownership is unsustainable (Marletto 2011). Newman (2007, p. 22) contends that "cities must plan and build to overcome car dependence" and Henderson (2006, p. 294) argues that the contestation of automobility is "about reclaiming urban spaces from automobiles, limiting their use, and more broadly, changing cultures so that the whole concept of high speed mobility and car ownership is de-emphasized".

Therefore, a paradigm shift towards 'sustainable mobility' has been proposed in the recent past. This paradigm encompasses three main areas: efficiency increase of the infrastructure and car usage, modal shift to more sustainable mobility concepts and measures to reduce mobility needs. The authors of this chapter aim at drawing special attention to the first of these areas by depicting fascinating opportunities for a radical increase in the efficiency of the car usage by novel mobility patterns. Above all, it takes a closer look at the arena of innovative mobility concepts which flourish at the frontier of digital technologies, shared mobility patterns and vehicle automation.

The authors aim at revealing several distinct fields of business model innovation which are possible by converging sharing concepts with car digitization and automation. Sharing concepts such as car- and ridesharing demonstrate important adjustments in the prevailing automobility paradigm. However, the combination of patterns of shared economy and autonomous vehicles represents a not that futuristic prospect of a total reconfiguration of this paradigm and hence a possible system innovation. This would be an important contribution to the shift towards the paradigm of sustainable mobility.[1]

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[1]The introduction is based on Janasz (2015): Brave New World—The Future of Automobility. Edited by Science Polish Perspectives Review. Cambridge.

2 Understanding Innovation in Urban Mobility

The literature review for this chapter has indicated that research at the frontier of sustainable mobility concepts, digital technologies and innovative business models is in its infancy. Therefore, it provides a wide range of opportunities for academic researchers and business practitioners to undertake research studies in these fields. Admittedly, recent contributions have recognized the value of advanced information and communication technologies (ICT) and investigated their possible applications for urban transportation systems. However, these applications refer chiefly to efficiency improvements of existing elements of the mobility system and not to possible innovations for a substantial paradigm shift in mobility. In that respect, one of the most researched topics has been the contribution of ICT to the development of intelligent transportation systems (ITS) which aim at optimizing the usage of existing infrastructure, however, not at challenging the existing urban mobility patterns. It can be also noted that a common understanding is missing of what exactly digital technologies are, how they are categorized and in what way they contribute to the development of innovative mobility concepts.

The arena of innovative business models for advanced mobility concepts based on digital technologies is in an emergent stage and the relevant discussions in the most recent academic and non-academic literature have just started. Admittedly, these contributions chiefly represent the applied research stream and therefore are strongly business-oriented. In this way fresh and innovative business ideas for the mobility sector can be identified. However, the literature often fails to demonstrate academic rigor and methodological discipline. For these reasons it can be claimed that there is a substantial gap in academic research within these areas.

Hence, in order to synthesize the knowledge about digital technologies, novel mobility concepts and innovative business models for the future of urban mobility a purposeful integration is required. In particular, the authors perceive urban mobility as constituted by five main elements which are in mutual interaction:

(1) *Value chain*, i.e., the sequence of activities that create products or services which customers are willing to obtain and pay for,
(2) Central *mobility services and innovations*,
(3) Latest advancements in *digital technologies and digital infrastructure* that support the implementation and the functioning of innovative mobility services,
(4) Relevant *actors* to be considered and involved and
(5) Possible *business model archetypes* that describe the processes for value creation, value communication, value distribution and value capture.

Figure 1 depicts the summary of findings that have been obtained during the literature review with regards to innovative mobility concepts for sustainable urban mobility.

It needs to be stated, however, that this is only a high-level summary of the conducted research. Due to the constraints of this chapter the comprehensive body of knowledge cannot be published completely. Therefore, the authors intend to

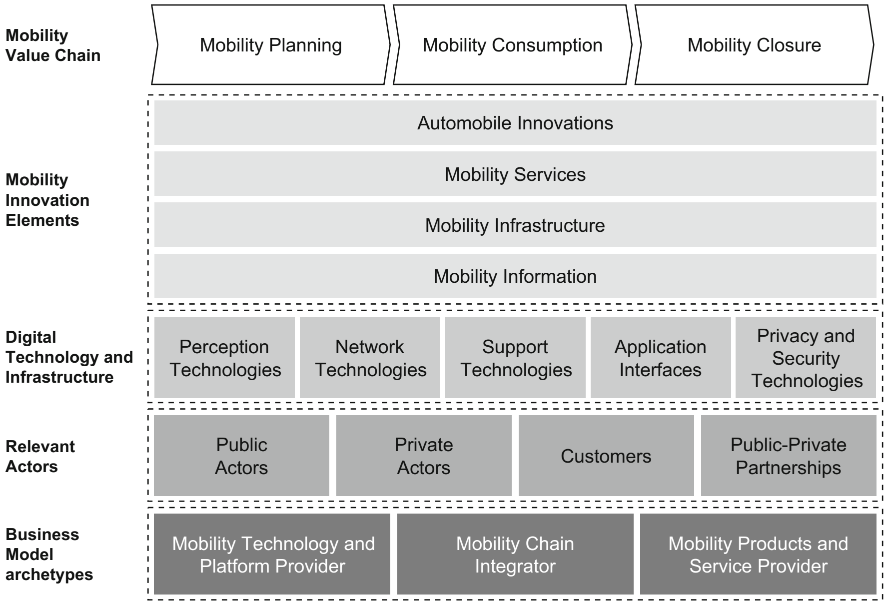


Fig. 1 Body of knowledge about the innovation in mobility (authors' own diagram)

extract key findings and insights with regards to the specific domain of business models for mobility services and current automobile innovations.

2.1 Business Models for Mobility Services

Innovative mobility concepts aim at addressing the market failure in the mobility sector which has occurred due to several reasons: increased congestion in cities, air pollution and environmental degradation, heath concerns, inefficient land-use patterns, insufficient access to high-quality transit alternatives and lack of affordable clean vehicles for consumers. Therefore, multiple actors, including public and private providers, seek to develop business models based on innovative mobility concepts in private and public transport to address these deficiencies (Cohen and Kietzmann 2014).

However, while necessary technologies seem to be available for integrated and intelligent urban mobility services, technological interfacing of different transport modes and infrastructures, seamless integration of technology as well as underlying management mechanisms are challenging (van Audenhove et al. 2014). Due to the overregulation of urban transportation systems the real innovation potential from the available technology is still rather untapped. One of the main reasons might be the hostile environment for innovation in which the organization and the management of urban mobility still operates. Confronting the challenges of urban mobility will require the adoption of new business approaches that would bring demand and supply into a natural balance (Lerner et al. 2012, p. 5). The private sector has recognized these challenges and started developing business models to address them (Cohen and Kietzmann 2014).

New business models are also a key megatrend within the automotive industry which currently has been facing many structural challenges, such as market stagnation, high sustainability requirements and the integration of electromobility in its product and service portfolio (Spickermann et al. 2014; Wells and Nieuwenhuis 2012). Thereby, highly integrated strategies are becoming increasingly important and greater public and private sector synergies need to be encouraged (Jones 2012; Spickermann et al. 2014; Cohen and Kietzmann 2014). For example, the growing importance of carsharing and multimodal information provisioning is expected to greatly support changes in automobility patterns (Firnkorn and Müller 2015; Costain et al. 2012; Spickermann et al. 2014).

The authors of this contribution believe that in particular the future of automobility strongly relates to the potentials of establishing innovative business models for overcoming the inefficiencies associated with the private car ownership and usage in urban areas, i.e., the idle time of cars when parked and the low occupancy rate when used. Therefore, the objective of the next part is to develop the understanding about innovative mobility solutions for overcoming these inefficiencies.

In order to develop an understanding about the field of business models for future mobility systems authors have included three general archetypes of business models (cf. Appendix 1): Mobility Service Platform Provider, Mobility Chain Integrator, Mobility Products and Service Provider. They can be reused by both private and public sector for business model generation and innovation in their specific context.

2.2 Important Technological Advancements in Automobility

Automobile technology encompasses several innovative developments. The most recent and prominent one is the exchange of the power train by alternative propulsion systems such as electromobility, hydrogen fuel cells or solar panels. Another innovation area is the ongoing semi-automation of cars. Several improvements are incorporated in commercially available vehicles (e.g., Tesla, Toyota Prius, Lexus RX-450h, Nissan Leaf). One example is the Intelligent Speed Adaptation (ISA) which dynamically informs the drivers about the current speed limit and has the capability to automatically limit the speed of the vehicle. Another one is the Intelligent Parking Assist System (IPAS) (van Audenhove et al. 2014).

However, the most radical innovations are associated with the increasing digitization of cars such as the digital car access and the technology of fully autonomous vehicles. The technology can be regarded as already available as many research programs, such as Google's Self-Driving Car Project (Google 2016) or Daimler's Mercedes-Benz F 015 Luxury in Motion (Daimler 2016), have been developing and testing it in the recent years, some also in everyday traffic situations. Furthermore, the concept of ‘connected mobility’ has also emerged in the research and the industry. It seeks to establish wireless links between cars and traffic infrastructure to exchange real-time data about the street, parking or weather conditions in order to compute appropriate trip routes and driving behavior for fleets of autonomous cars.

2.2.1 Digitization and Connectivity

By enabling vehicles to communicate with each other via vehicle-to-vehicle (V2V) or with roadside base stations via vehicle-to-infrastructure (V2I), digital technologies can contribute to safer and more efficient mobility (Dimitrakopoulos et al. 2012). Such communication technologies will allow a car braking abruptly to alert the vehicles behind it to automatically trigger their emergency brake. It will also support safe navigation, pollution control and traffic management. For such applications, however, connectivity is an essential factor. Cars will need to extend their features to become ICT platforms which absorb information from the environment and other objects and transmit their own data to the infrastructure. Gerla et al. (2014) labels it as an Intelligent Vehicle Grid. In order to support this development cars’ internal networks need to be able to communicate (e.g., via CAN bus) with external sources using communication standards such as: USB, Bluetooth, Wifi or 3G/4G networks (Koscher et al. 2010).

This clearly indicates that car manufacturers are required to join forces with tech companies. A good example of such a vehicular grid is the recent alliance between Samsung, SAP and SEAT which aims at establishing new car based services around such communication and data exchange. The cooperation has resulted in developing a future concept for parking in urban areas. With this concept car drivers get access to a global parking inventory of connected ‘on-street’ and ‘off-street’ parking spots which can be reserved from any location through fingerprint recognition. The system then navigates the drivers to the specified location and automatically raises the access gate when the car approaches. When the driver exits the car garage, payment is made directly from the app without leaving the car. Such seamless integration can make urban parking simple for drivers and significantly reduce the search time and the associated traffic.

2.2.2 Fully Autonomous Vehicles

Advancements in autonomous resp. driverless cars, which operate using a combination of sensors, video cameras and artificial intelligence software, can bring about some radical innovations in this specific transport area. Autonomous car technology shows a tremendous development, with Google taking the lead. It is expected that the technology will mature within the next decade (The Economist 2014). The hardware used in Google self-driving cars includes Light Detection And Ranging

(LIDAR), radars, cameras, and GPS sensors. The LIDAR data is combined with high resolution maps to create a detailed 3D and 360° map of the environment (Thrun 2010). The system of sensors is provided with a tremendous amount of information, around 750 MB/s, which is far more than a human driver could ever acquire (Shankland 2013). The software is essential to robotic driving as it conducts tasks in six areas: sensor data preprocessing, localization, obstacle tracking, path planning, behaviors and control of the vehicle (Thrun 2010).

However, it seems that the advances in the arena of car digitization and automation are only the required foundation for further and more innovative vehicle centric applications, which are already being pioneered, for example, by Google. It has been argued that the next step in this evolution is the 'Internet of Autonomous Vehicles', a network of Internet-connected autonomous vehicles (Gerla et al. 2014).

3 Emerging Digital Mobility Concepts for Overcoming Car Dependency

The challenges of automobility in urban areas arise from both (i) their over-engineered characteristics, e.g., a typical car can reach speeds of well over 160 km per hour, whereas typical urban driving speeds range from between 24 to 40 km/h, and (ii) their underutilization, e.g., private automobiles remain parked for more than 90 % of the time (Barter 2013; Shoup 2005; Center for Sustainable Systems, University of Michigan 2015). Even though these problems have been widely recognized the challenge remains to keep the benefits of privately-owned cars while removing the dependency on non-renewable resources, minimizing pollution, and avoiding the need for additional road infrastructure and parking space in the urban area.

In this respect, especially sharing concepts, such as car- and ridesharing, have been recently introduced as a novelty with regard to the patterns of car usage. Even though these concepts have been known and implemented for more than 30 years, it needs to be stated that car- and ridesharing have experienced an exceptional come-back in recent years. It is thought that high urbanization and digitalization processes in the society have favored their revitalization and flourishing.

Below the authors will explain both mobility concepts in more detail, introduce two innovative market players and develop an in-depth understanding about their underlying digital business models. For this specific analysis the authors have developed their own 'P4C Business Model Framework'. This framework is based on the value-oriented approach by Osterwalder and Pigneur (2010), which has also been referred to in the chapter 'Designing Business Models for the Digital Economy'. The description of the underlying business model framework has been attached in Appendix 2.

3.1 *Digital Carsharing*

3.1.1 Mobility Concept Description

Sharing cars is an entrepreneurial approach which is built on the recognition that an idle car is an immense 'wasted asset', which means that it is greatly underutilized. If a car is idle for most of the time then not only does it occupy valuable space in cities but it causes substantial losses in the form of depreciation. From this perspective the concept of carsharing could lead to a much higher utilization of available car fleets and possibly also to the reduction of the overall amount of the cars on the streets.

With reference to the underlying business concept carsharing programs seek to shift personal transportation choices from asset ownership to a service which is being provided 'on-demand' (Fagnant and Kockelman 2014). This business model is referred to as product-to-service, servitization or 'rent instead of buy' pattern (Abdelkafi et al. 2013; Johnson 2010; Gassmann et al. 2013). To be more precise, a number of past studies have attributed carsharing as a use-oriented and product-service system (Mont 2002; Tukker and Tischner 2006; Williams 2007). In that sense the value proposition is not the product itself but the 'job-to-be-done' (Christensen 1997), which would be the mobility service in this case. According to Weill et al. (2005) selling the right to use assets might be even more profitable and more highly valued by the market than selling the ownership of assets.

The financial model of a carsharing organization is based on member revenues, sponsorship, government subsidies and grants (Cohen and Kietzmann 2014). Carsharing institutions may be organized as a commercial business, or users may be organized as a public agency, cooperative or an ad-hoc grouping (Tietenberg 2007). In general, there are four possible organization schemes for a 'Carsharing Service Provider' (Lerner et al. 2012; Cohen and Kietzmann 2014): business to customer (for private end-users), business to business (corporate carsharing), peer-to-peer (customer-to-customer) and nonprofit.

3.1.2 Case Study: smexx

Introduction

smexx GmbH[2] is a company that offers hardware and software for keyless access to vehicles and other electronic locks. Smexx was established in the beginning of 2016 as a new formation of carzapp GmbH. Carzapp was an award-winning start-up from Berlin (Germany) that aimed at revolutionizing the carsharing market with its patented hardware solution ZappKit, an installed bit of hardware that enables smartphone-based access to any car. It was carzapp's CEO, Oliver Lünstedt, who stated that ZappKits implemented in 100,000 cars would have the potential to

[2]GmbH (Germ.) stands for limited liability corporation (Amer.) or private limited company (Brit.).

replace 1 million cars on the roads (Mechnich 2014). The carzapp company was originally founded as a peer-to-peer carsharing platform provider (similar to GetAround or RelayRides) based on its technology stack: ZappKit access unit, software and online platform. Although the carsharing platform still exists it is currently one of several segments that the company operates in. smexx aims at providing a variety of application options of the ZappKit and services chiefly in the B2B-sector. Therefore, smexx has recently shifted its business strategy and re-launched as a ‘white label’ carsharing and freight delivery enabler with its technology stack: the ZappKit access unit, software and the online platform.

The unique features of the toolkit enable such an approach. It allows spontaneous renting of cars without the need to hand over the keys, since the hardware enables digital car access, i.e., keyless opening and closing of vehicles, via a smartphone. It can be installed in all kinds of vehicles which have a central locking system. With other embedded digital technologies such as GPS and GSM the solution offers some further unique features such as: forwarding of all necessary information to the police in case of an attempted theft or having to locate the vehicle and to calculate its route. In addition to the hardware, the company offers a scalable and comprehensive software solution, including a white label platform for fleet management of vehicles equipped with the ZappKit. The solution is also ECE certified which makes it applicable possibly to almost every vehicle. While the company had originally developed its hardware for motor vehicles, now also heavy equipment, garage doors, and electronic door locks can be equipped with the ZappKit.

Use Cases

As of 2015, smexx has been maintaining two strategic partnerships in order to provide innovative services in the area of smart access to a wide range of customers. The company partners with the largest independent leasing bank for car dealers in Germany as well as with T-Systems, one of the largest German IT services company. The partnerships are designed to provide services based on the ZappKit technology to the end customers of involved partners.

The partnerships with the independent leasing bank aims at providing ‘carsharing-ready’ cars to dealers and their end-customers. Car dealerships can extend the range of their services by becoming carsharing service providers. For that purpose smexx provides and operates the platform and additional cross services such as payment, billing and the call center. In addition, in accordance with the leasing bank smexx connects the carsharing-ready cars and additional end users with its own carsharing platform in order to achieve scale effects.

T-Systems is the strategic partner for providing the ZappKit technology to freight delivery companies which supply components and spare parts to professional tradesmen at nighttime. With regard to this customer segment smexx offers innovative ‘in-car’ and ‘in-night’ delivery services. The idea behind in-car delivery is that cars, in particular their trunks, can be utilized as smart lockers for freight delivery. This happens while the car is parked. In the case of in-night delivery the warehouse employees can easily access every truck during their night shift in order to load them before the daily touring begins. For example, T-Systems has more than 10,000 cars in which spare parts for service technicians are being delivered during the night. Additionally, there are also warehouses (such as containers, garages), which still operate based on physical key solution. Process costs occur due to key management (e.g., ordering a spare key or lost keys) and car searching by logistics provider. By installing ZappKits T-Systems considerably simplifies the process for the freight delivery companies by enabling following digital functionalities:

- Tracking cars' locations via GPS,
- Unlocking via cards with near field communication (NFC) sensors,
- Logging who has accessed which car at what time to avoid problems due to cars being left open after delivery etc.

Current pilot customer has expanded from 30 to 850 equipped access points for the in-night delivery service. In this case, the benefits encompass faster availability of goods and a much better utilization of drivers, technicians or tradesmen.

3.1.3 Business Model Analysis: smexx

In this section the authors take a closer look at the characteristics of the underlying patterns and illustrate smexx's business model in accordance with the current theory in the field of business model design. The outcomes of the analysis are depicted in Fig. 2.

With its ZappKit the company has been deploying a white label business strategy. White label products or services are produced by one company, i.e., the producer. Other companies, the marketers, rebrand these products or services and let them appear as if they have made them (Gassmann et al. 2013). The producing company can direct its attention to further optimization of its products and services. Thus the company has better opportunities to achieve economies of scale (Gassmann et al. 2013).

The business model pattern which applies to smexx's business approach is the *intellectual landlord model* (Weill et al. 2005). This business model can take two distinct forms: *licensor* or *franchisor* (Andrew et al. 2013). In the case of a franchising system, the franchisees would be allowed to carry the name of the franchisor and apply its processes and technology (Abdelkafi et al. 2013). This is clearly not the case with the business model of smexx because the company delivers white label solutions. The smexx technology, which encompasses the ZappKit hardware, the associated software platform and the mobile app, has been licensed to the leasing bank and to its customers, i.e., the car dealers. The licensees use the digital technology, processes and the intellectual property of smexx, however, under the label of the leasing bank. The system involves fees that should be paid to the licensor. With that in mind, smexx is de facto an ICT platform provider offering a scalable end-to-end carsharing platform.

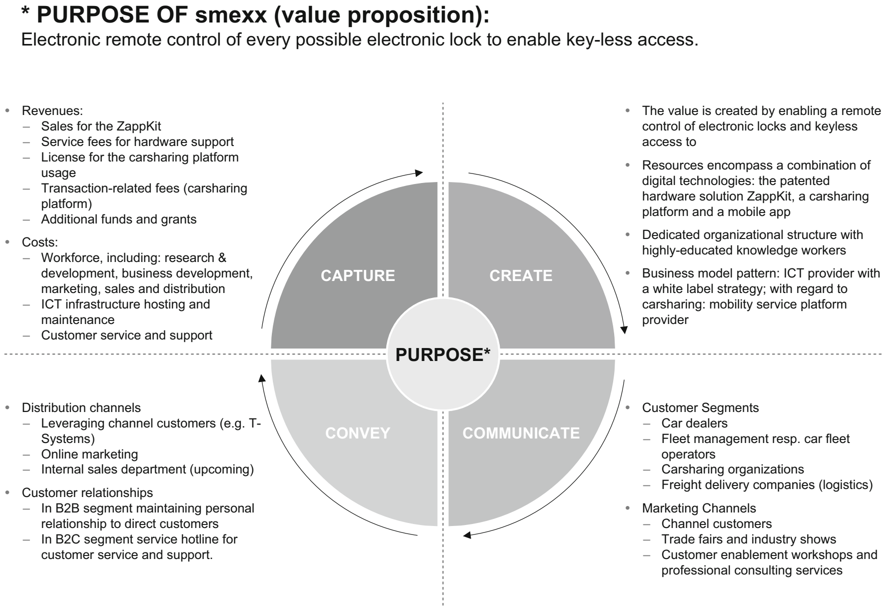


Fig. 2 The P4C business model framework applied to the smexx company

However, it needs to be noted that smexx is not only a pure technology provider. As a matter of fact, the company provides a range of value-added services. The smexx all-round carefree package includes both (i) one-stop-shop digital processes such as: identification, information brokerage, booking, payment and billing, and (ii) professional services such as: customer services and professional management consulting. With that in mind, smexx can be also denoted as the *mobility service platform provider* (Lerner et al. 2012).

The unusual venture between a financial institution and a technology supplier smexx has proposed a completely new approach to providing carsharing mobility services. The business concept behind it has not been offered in this form by any other institution before. The pioneering idea about this particular carsharing approach is that it offers a possibility to set up a brand-independent carsharing service. The car dealerships can provide a carsharing service to their end customers, independently of the OEM, by deploying both the smexx technology and their available vehicle fleet. Additionally, the service can be used by customers across the entire smexx system which contributes to the possibility to scale the carsharing system area-wide. Such an approach bears the potential for remarkable growth not only in the user base, but also in hardware and software sales.

3.1.4 Digital Carsharing Business Model Prototype

The ubiquitous access to the Internet, wide-spread diffusion of mobile devices and other digital technologies can further contribute to the development of the carsharing paradigm. A purposeful integration and implementation of digital technologies could lead to establishing a platform system with open access for every market participant, which is globally scalable and does not require capital intensive investments. The goal would be to connect as far as possible underutilized cars to a global system and offer carsharing services to the market.

As the case of smexx indicates, dedicated technology can enable a network of manufacturer-independent carsharing programs that are integrated across each other on a single and global platform. Such a business model prototype can be defined as 'Digital Carsharing' which offers next-generation shared mobility through a digital and key-less access to every car and the possibility to timely synchronize their usage. The focal point being addressed here is the increase of productivity of available vehicle fleets in terms of the number of car-journeys that are provided by a car on a single day. Therefore, the business model serves the purpose of eliminating the 'car-usage inefficiency' in urban areas, i.e., extending the time cars are actually utilized for travel.

The purpose of a digital carsharing provider is to connect underutilized cars to a global carsharing system. This prototype is based on a range of digital technologies and instruments that enable the provision of carsharing services based on existing car fleets and privately owned cars:

- Multi-sided platform and mobile apps for virtual communication and transactions between car owners, car users and other involved partners (e.g., insurance institutions, payment platforms),
- Key-less digital access to every vehicle with a mobile device (e.g., smartphone),
- Automatic mobile payment options,
- Provision of viable insurance options,
- Establishment of trust mechanisms.

Digital carsharing business model offers quality segmentation, full price transparency and low transaction costs by overcoming physical intermediaries. With that it re-envisions the entire customer experience and makes carsharing schemes convenient, appealing and mainstream capable. The following mobility concepts are possible to implement:

(1) Business-to-customer carsharing, i.e., manufacturer-bound.
(2) Corporate carsharing, for a specific corporate fleet.
(3) Private carsharing resp. peer-to-peer carsharing.
(4) Digital Dispatching for Taxi Services.
(5) OEM-independent carsharing.
(6) Optimized Fleet Management.

3.2 *Digital Ridesharing*

3.2.1 Mobility Concept Description

As opposed to carsharing where the car itself is subject to the service offering, ridesharing aims at offering and utilizing the available space within the cars. The space refers to the seats which are freely available in cars that carry less people than actually allowed or possible. Therefore, ridesharing is associated with car drivers allowing other passengers to ride in the same vehicle from the same or a similar origin to the same or a similar destination (Cohen and Kietzmann 2014; Chan and Shaheen 2012).

Since the infancy of the Internet numerous ridesharing schemes have integrated the Internet, mobile devices, and social networking into their services making them much more efficient and convenient for the users (Chan and Shaheen 2012). Today, there are various ridesharing concepts in place which are much more advanced in their functionality compared to the previous carpooling approaches. Generally, ridesharing can be categorized into two distinct forms: long-distance and short-distance ridesharing. The first one refers to journeys above 200 km and covers inter-city trips (e.g., BlaBlaCar), whereas the latter approach focuses on car rides below 200 km and aims chiefly at daily commuter journeys. There are the following ridesharing mobility concepts: traditional carpooling, flexible carpooling, vanpooling, shared taxi services and peer-to-peer dynamic ridesharing (Chan and Shaheen 2012; Cohen and Kietzmann 2014; Martinez et al. 2015; Arnould et al. 2011; Kelly 2007; Ferreira et al. 2009). Ridesharing is also referred to as a costsharing service and is defined as non-profit. Therefore, the majority of ridesharing programs are not associated with drivers seeking to gain profits. The goal is rather to contribute to the cost relief of the vehicle owner, while contributing to reduced traffic congestion and pollution at the same time (Cohen and Kietzmann 2014; Chan and Shaheen 2012). In that respect, it is valid to question whether Uber can be described as a ridesharing platform, since the drivers that use Uber services aim at gaining profit and sharing costs.

The case study of TwoGo® by SAP should illustrate the ridesharing concept in more detail.

3.2.2 Case Study: TwoGo® by SAP

Introduction

The headquarters of SAP SE are located in Walldorf (Germany), a small city in the Rhein-Neckar district 80 km from Frankfurt. According to internal source there are 25,000 company cars in operation globally. Only at headquarters in Walldorf there are 10,000 company cars distributed among the staff, which in 2016 amounts to approximately as many as 13,000 employees. In 2014 approximately 75 % of them used cars for their journeys to the campus. Additionally, according to the SAP Sustainability Dashboard the average distance of all commuters in that year was 46.1 km and the occupancy rate of the cars used for these trips was as low as 1,1 persons per car. This state of matters with regard to employee's commuting behavior had been already recognized before at SAP. Therefore, an internal corporate ridesharing program was considered in order to generate savings in gas emissions and costs related to commuting. As a matter of fact, the idea was initiated by two SAP developers back in 2009. They had been allowed to spend a fixed amount of their working time on the development of an intelligent solution and were soon supported by other colleagues and external consultants. After several months of the development phase the first version of TwoGo by SAP was announced and introduced.

Use Case

TwoGo by SAP is a mobile, cloud-based ridesharing service. Drivers register online and specify the requirements such as the desired radius of the place of residence and the time for departure and arrival. The same applies to riders who can specify the pick-up location and their desirable timing preferences. TwoGo by SAP automatically matches the demand with supply and offers suitable rideshare option for both parties.

Since July 2011 SAP has been using the solution internally. After the test phase TwoGo by SAP has been brought to other countries: Austria, Brazil, Mexico, Belgium, Canada, France, Germany, Hungary, Ireland, Italy, Singapore, India, Spain, Switzerland, Portugal, Bulgaria, UK and the US. As of today, other locations are also being scheduled for deployment. The company claims that in the period until April 2013 TwoGo by SAP created 36,000 carpools and more than 5 million dollars of value for SAP which can be attributed to following tangible and intangible benefits (SAP News 2013):

- Cost savings related to commuting to work; for example, reducing fuel consumption and maintenance costs and increasing the resell value of company cars.
- Expense avoidance related to employee travel such as reimbursements for fuel, limo services or parking.
- Increased networking among employees by matching employees into carpools more than 36,000 times and adding 2200 additional days of networking time among employees.
- Reduced greenhouse gas emissions by helping to eliminate 400,000 miles of driving and avoiding 88 t of greenhouse gases.

Since 2013 TwoGo by SAP has also been commercially available to the external market as a cloud offering. As of 2014, individuals, too, can register for free at the TwoGo by SAP platform and find a ride to work or back home in a dynamic and flexible way.

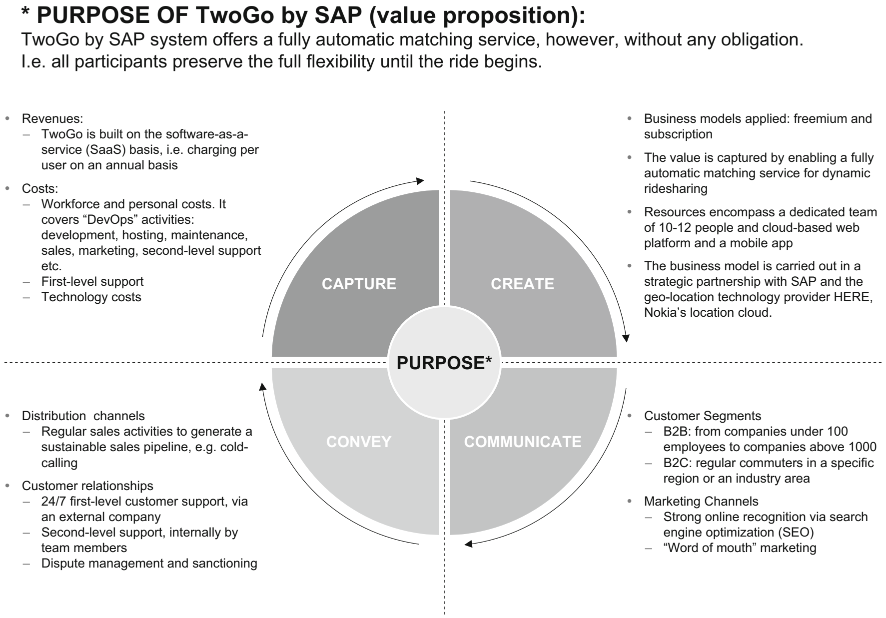


Fig. 3 The P4C business model framework applied to TwoGo by SAP

Business Model Analysis

For a detailed analysis of the TwoGo by SAP business model authors have again applied the P4C Business Model Framework (cf. Appendix 2). The high-level findings are depicted in Fig. 3.

The general business model pattern behind TwoGo by SAP can be referred to as a multisided platform. In the classification of Osterwalder and Pigneur (2010) the multi-sided platform business model aims at bringing different groups such as buyers and sellers together and to facilitate the interactions between them. TwoGo by SAP bundles the supply of and demand for shared rides on one platform and enables easy and convenient matching. However, such platforms are only successful, if a critical mass of users is reached. This is referred to as network effects (Abdelkafi et al. 2013). It corresponds with the goal of the development team to reach as wide-ranging audience as possible.

Additionally, TwoGo by SAP is currently characterized by the combination of two further patterns which relate to the underlying pricing models, i.e., the generation of cash flows. The first one is akin to a 'freemium' business model. It consists of giving access to the platform free of charge and finding other sources to generate profits (Johnson 2010). The second pricing model implemented by TwoGo by SAP is the 'subscription' approach. Subscription is a type of fixed pricing, in which the customer pays a fixed amount of money to use the service for longer periods at any convenient time or frequency (Al-Roomi et al. 2013). It is also a model which has been implemented for providing cloud applications resp. software-as-a-service. As opposed to the ‘freemium’ approach it aims at generating positive cash flows. While paying a regular fee customers gain access to an advanced service, which allows convenient use of the offering and high price transparency (Johnson 2010).

3.2.3 Digital Ridesharing Business Model Prototype

By combining mobile devices with instant network connectivity, mobile geolocation technologies and the power of social networks a so called real-time ridesharing mobility concept has recently been enabled. Real-time ridesharing uses Internet-enabled smartphones and highly automated ridematching software applications. In this way shared rides can be organized dynamically, i.e., in real-time.

The business model prototype categorized as ‘Digital Ridesharing’ offers a next-level of shared mobility through technology-enabled access to every car-seat and its effective utilization. The model aims at optimizing the efficiency of car seats for every car-journey. Hence, it serves the purpose of eliminating the ‘seat-usage inefficiency’ in vehicles. Classical ridesharing systems are inefficient because they require:

- Pre-defined relationships,
- Both parties must be in proximity of each other, and
- Passengers must arrange return trips.

As opposed to these traditional ridesharing services digital ridesharing intelligently and dynamically matches drivers willing to share journeys with travelers who need a ride. The specifications of the ‘Digital Ridesharing’ business model include (Arnould et al. 2011):

- Users specify their intended journeys and are matched with other users with similar intended journeys. It enables a carpool between people who do not have pre-defined relationships.
- Digital ridesharing is a dynamic carpooling transport system, reacting in real-time to events and user transport requests. Hence, the ridesharing service can be provided to random users on the move, whether they are in their cars or simply walking by.
- Digital technology (e.g., applications via smartphone) enables a comprehensive wireless communication and fully automated booking procedures. The digital ridesharing platform enables establishing vehicular networks and seamless integration with other transport modes.
- The service gives flexibility and transparency in the form of price and quality segmentation, and low transaction costs.
- It saves money, reduces the amount of cars on the road, striving to reduce accidents and traffic congestion. Hence, the service is environmentally friendly.

However, some further critical issues are still open and need to be considered in future research (Arnould et al. 2011; Le Vine 2014):

- A clearing service needs to be implemented to solve the inherent compensation issues.
- Clarification regarding the usage of surge pricing is needed. For example, it has been eagerly disputed whether UBER is a ridesharing service or an ICT platform provider that offers regular transportation services for fees.
- As with ridesharing apps, the capacity and legal powers of public sector institutions to regulate a secondary-exchange market in shared-mobility is still an open question.
- Further research is needed to identify such legal and institutional issues, as well as the implications of the various possible public–private partnerships which are characterized by a range of types and intensities of interactions.

Companies assuming this business model prototype aim at commercializing the inefficiencies associated with the current low occupancy rates of private cars. They can provide dynamic matching services at 'almost zero' marginal costs and very low transaction costs. The following mobility concepts are possible:

(1) Business-to-customer ridesharing.
(2) Corporate ridesharing, i.e., limited only to one company.
(3) Private ridesharing, i.e., peer-to-peer mobility.
(4) Shared Taxi Services.
(5) Optimized Fleet Management.

4 Designing Business Models for the Future of Automobility

This chapter examines key mobility innovations in the sector that can be labeled as 'Shared Automobility Services' and which has emerged at the frontier of aforementioned sharing concepts, car digitization and vehicle automation. In particular, the study will analyze the development in the following niche areas of mobility services based on cars:

- On-demand mobility concept.
- Services for autonomous vehicles.
- Fleets of shared autonomous vehicles.

The research work explores new insights into the field of shared automobility services and should encourage further research. For the purpose of collecting data and developing mobility concepts expert interviews with ten selected mobility experts and startup entrepreneurs from Switzerland and Germany were conducted in the period from 2014 to 2015. The research was conducted within the scope of the doctoral thesis *'Paradigm Shift in Urban Mobility: Towards Factor 10 of Automobility'* (Janasz 2016 forthcoming). The detailed research design, list of interviewees, transcripts and data analysis are inherent to this dissertation.

In the next sections the authors will present several developments of promising innovative mobility concepts flourishing at the frontier of digital technologies, car automation and shared mobility patterns. They will especially make an attempt to describe possible business model innovations for such mobility concepts. The analysis has been conducted by means of the P4C Business Model Framework (cf. Appendix 2).

4.1 Automobility on Demand

4.1.1 Mobility Service Description

One of the most promising strategies for urban mobility is the concept of a one-way carsharing scheme which utilizes small-sized and electric cars. Such a mobility concept is also referred to as free-floating carsharing or mobility-on-demand system (MoD). The system aims at providing a network of light electric vehicles which are distributed and accessible to subscribed citizens throughout a city, however, it is often limited to a central urban zone (Mitchell et al. 2010). The usage is based on the on-demand principle: travelers use a smartphone application to find a car in their immediate proximity. If it is available they reserve it for the next 15 min. Then they walk to the vehicle, swipe a card to pick it up, drive to the selected destination, and they drop it off at an available public parking spot (parking spaces are usually provided in close cooperation with municipalities).

Such MoD fleets, which are additionally equipped with electric vehicles, are directly targeting the problems of oil dependency, energy efficiency and pollution (assuming renewable energy sources), and parking spaces via higher utilization rates and less need for parking. Furthermore, they ensure more flexibility with respect to the conventional two-way resp. station-based carsharing. Hence, they provide personal, anytime mobility, in contrast to traditional taxi systems or alternative one-way sharing concepts such as ridesharing or vanpooling (Pavone 2015).

MoD systems are being advocated as a key step toward sustainable personal urban mobility (Mitchell et al. 2010). On-demand carsharing mobility concepts may offer substantial benefits to both users and local transportation networks. Shaheen et al. (2006) indicate that carsharing membership reduces vehicle miles travelled (VMT) by 44 % on average in the US and by between 28 and 45 % in Europe. Martin et al. (2010) reports that every shared vehicle can result in the removal of approximately 9–13 private vehicles from the roads, either by members selling a privately owned vehicle or by postponing a car purchase. Based on the Carsharing City Ranking 2015 in Germany one carsharing vehicle replaces up to 10 private cars (bcs 2015).

MoD systems, however, present a number of limitations. For example, due to the spatio-temporal nature of urban mobility, trip origins and destinations are unevenly distributed and as a consequence MoD systems inevitably tend to become unbalanced, i.e., vehicles build up in some parts of a city, and become depleted at other locations. Additionally, it needs to be noted that further possible rebound effects may occur and need to be taken into account. For example, some experts explicitly criticize the free-floating carsharing approach for actually increasing the traffic in cities rather than neutralizing it (civity Management 2014; Harder 2014). They would not directly contribute to a reduction of congestion, as the same number of vehicle miles would be traveled with the same origin–destination distribution. Indeed, more vehicle miles would be conducted, considering trips to rebalance the fleet. A recent study of a free-floating carsharing program in Berlin revealed that the cars are mainly used for leisure activities and chiefly in the evening hours. Accordingly, this would not contribute to the relief of the rush hour traffic in Berlin. Rush hour is caused mainly by commuters and they would not use carsharing for their journeys. Hence, it is likely that free-floating carsharing schemes could rather contribute to more overall traffic in Berlin, since it is much more convenient than the public transportation system (Harder 2014). In that sense the free-floating carsharing concept would actually directly compete against the environment-friendly public transportation system.

One of the current challenges with carsharing programs is also their fragmentation. There is an increasing number of organizations that offer carsharing services, however, they are not integrated and are chiefly based on proprietary systems. Some estimates suggest that currently there are more than 600 different carsharing providers around the globe (Cohen and Kietzmann 2014). Additionally, establishing an area-wide carsharing scheme is a challenging endeavor since the carsharing service provider needs to operate and maintain an own car fleet (unless it is a P2P scheme which does not require an own vehicle fleet). Currently, it seems that the provision of such unilateral carsharing systems is only possible for big market players. Such players are, for example, automotive manufacturers that are in a position to provide the required number of vehicles and that have the capital for setting up their services in major tier-one cities of the world, i.e., cities with a population in excess of 600,000. Such examples are Daimler's Car2Go (a one-way rental company operating over 10,000 two-passenger vehicles in 26 cities worldwide) and BMW's DriveNow. Hence, such area-wide services are limited to very dense urban areas. This might pose a severe limitation to the wider spread of carsharing services to tier-two cities, i.e., mid-sized towns with a population of 250,000–600,000 people, or to less dense suburban areas. Above that, the fragmentation of the carsharing market can also lead to a limited and localized use of carsharing service, since the overarching integration of different carsharing services is not yet in place. Interestingly, these deficiencies open new opportunities for further innovations by implementing digital technologies. For example, CarJump, a start-up company from Berlin, aims at consolidating all possible carsharing services in the specific area within one mobile application. CarJump allows finding available vehicles in the neighborhood, to compare them, select the best one and directly book it via an app (CarJump 2015).

4.1.2 Definition of the Business Model Prototype

The business model prototype 'Mobility on Demand' assumes the product-to-service shift, i.e., establishing a use-oriented mobility concept. The mobility service proposed here is based on a fleet of shared and city-friendly vehicles which are distributed area-wide. These vehicles are on-demand, which means that the mobility service can be obtained fully flexible and spontaneously. Companies pursuing this strategy act as 'Mobility Service Providers'. They focus on the core competence which is the delivery of a standalone solution to municipal administrations or to mobility chain integrators. The high-level analysis has been conducted by the elements of the previously proposed P4C Business Model Framework (cf. Table 1).

4.2 Autonomous Vehicles

4.2.1 Mobility Service Description

Autonomy with respect to the automobile means an ongoing automation and interconnection of vehicles and traffic infrastructures with the ultimate aim to enable a mobility system which will depend on fully self-driving cars (Baber et al. 2005). In such a system tasks and decisions previously allocated to a 'human driver' are now to be entrusted to a 'computer driver'. The embedded technology for the automation extends the capacity of the human driver, i.e., the agency of the driver, to act more independently within the car. Thus, the driver is being 'converted' to a passenger (Weber et al. 2014).

The shared opinion is that traffic safety would increase considerably since it is also believed that driving abilities of computers outperform those of humans. The technology also promises more comfortable car journeys, lower insurance costs and better fuel-efficiency (Marks 2012). Another prominent advantage of autonomous driving is offering automobility to non-drivers who have been excluded from automobility. For example, according to Google, blind and disabled people could be strong beneficiaries of autonomous driving (medGadget 2012). Some experts also expect the resolution of the congestion issue in urban areas because the autonomous technology is considered to be able to optimize the efficiency of the transport infrastructure (Kornhauser 2013). However, this argument has been taken issue with as there might be possible rebound effects. There is a general awareness that improvements in the area of energy efficiency, safety or quality of driving may lead to an increased demand for such autonomous mobility which could actually induce additional car travel. In consequence, this could lead to a substantial increase in external costs caused by cars and could also put the public transportation systems under extraordinary pressure (Litman 2014).

Table 1 Business model prototype 'mobility on demand'

P4C business model framework elements	Description
Propose value	Flexible on-demand and key-less access to vehicles on the city streets in order to satisfy the situational mobility need
Create value	Provide on-demand automobility by: – Owning or operating a fleet of city-friendly cars – Enabling key-less access to cars, preferably in a digital way – Ensuring rebalancing and realigning of the fleet throughout the city perimeter Establish strategic partnerships with: – Carsharing technology and platform providers – ICT platform operators – Public transport operators – Public authorities – Payment operators – Provider of geo-localization and location-based services
Communicate value	Mobility users: – Get flexible on-demand access to vehicles – Perform a trip according to your situational requirement – All-inclusive charging (e.g., maintenance, insurance, fuel/electricity, parking) – Eliminate the first mile/last mile problem – Leave the cars on the public parking space – Secure urban mobility without the need of car ownership Municipalities and society: – Provide additional mobility alternative, hence increase the accessibility and locational attractiveness – Establish a necessary building block for multimodal urban mobility – Potentially help reduce car ownership, automotive emissions and parking requirements – Redesign traffic infrastructure and make space for new land-use patterns – Be recognized as an innovative and sustainable city
Convey value	– Location management (appropriate sizing of fleet of urban vehicles, zoning, manage relationship to local municipalities) – Providing fleet access via well designed and user-friendly mobile apps – Digital B2C relationship management on all channels: • E-Mail-marketing • Online campaigns (e.g., AdWords, web banners) • Landing pages and mobile apps • Social media marketing (e.g., YouTube, Tweets, Facebook) • Content marketing – Multichannel B2B-marketing for the corporate segment – Appropriate management of the 'Business Network' and partner structures
Capture value	– Pay-per-use operating model, for example, pay-per-minute and/or kilometer – Subscription model

4.2.2 Definition of the Business Model Prototype

For the providers of autonomous cars, i.e., the manufacturers, the business model will further rely on selling cars to specific customer segments. Authors believe that further business models appear to be viable.

Assuming that such development will take place in the not-too-distant future it is worthwhile to consider what human drivers, who are to be 'degraded' to the role of passengers, will do with the spare time gained during a lengthy car journey. It is being argued that the motivation for companies to provide such autonomous technology does not lie in altruistic impulses such as contributing to road safety or enhancing parking space utilization, even if these are likely to be major benefits for the society, but rather some other more opportunistic aspects. Instead, industry experts claim that actors, such as Google, are interested in freeing up spare time for passengers in order to give them additional opportunities to be connected to the Internet. This would enable the provision of additional services and products during the journey (Austin 2016). In that respect, there are several commercialization ideas that would be conceivable:

- The ability to work or rest while traveling would enable the provision of services in the vehicle, such as consulting services, online shopping, video streaming, playing games etc. Experts claim that also ill-conceived marketing strategies would emerge such as 'commuter sex' (Litman 2014);
- Using cars for local deliveries of goods during vehicle's idle time. For example, already today UBER offers on-demand delivery services such as lunch or ice delivery for free, albeit not yet fully autonomously (Spector 2015);
- Other services that can be run mobile, for example, delivery of the laundry or flu shots.

The condition for providing a range of value-adding services is that OEMs undertake a full digitization of their vehicles and to also establish access to car data for third parties via application interfaces and external digital platforms. Therefore, the OEMs would need to extend the car to become an environment for collaboration between different service providers. In that sense companies assume this business model to not provide a mobility service per se, but rather act as 'Intermediaries' linking multiple buyers and sellers. Optional business strategy would be 'Vertical Integration', i.e., providing vehicles, integrated mobility services and value-adding services from one hand. Premium manufacturers pursue such an approach. A case in point being Tesla which is bypassing traditional dealerships to sell its cars directly to the consumer while also building the world's largest battery plant (Favaro 2015). Table 2 depicts the proposition of a business model prototype for delivering additional services for owners and passengers of autonomous vehicles.

Table 2 Business model prototype 'autonomous vehicles'

P4C business model framework elements	Description
Propose value	Full autonomy in the car as well as stress-free and safe automobility
Create value	Sell cars that feature the following characteristics: – Equip vehicles with autonomous self-driving technology – Open up the vehicle to full digitization Provide value-adding services (e.g., connected parking) in the car by: – Establishing an ICT platform and providing proprietary value-added services (e.g., Ford's AppLink) – Enable third party digital services delivery (e.g., via Google's Android Auto or Apple's CarPlay) Establish strategic partnerships with: – ICT platform operators – Public transport operators – Payment operators – Providers of geo-localization and location-based services
Communicate value	Car owners and passengers: – Full autonomy: transformation from a driver to a passenger – Full journey safety and trip comfort – Freed up time for other activities during a car journey: work, relax, online shopping, consulting services etc. – Utilize the car for other less valued activities such as: delivery and pickup of packages and other assignments (groceries, laundry etc.) – Yield earnings from the car by enabling P2P carsharing and dynamic ridesharing service Municipalities and society: – Enable an additional mobility alternative, hence increase the accessibility and locational attractiveness – Ensure high road security standards with almost no accidents and fatalities – Potentially provide more efficient traffic flow. However, questionable due to additional empty vehicle miles and more convenience as compared to public transport – Redesign traffic infrastructure and make space for new land-use patterns – Be recognized as an innovative city that ensures high standards of quality of life (by minimizing road hazards)
Convey value	– Direct marketing with no intermediaries (level zero) or authorized reseller distribution channels (level one) – Value-added resellers (VAR) responsible for integrating appropriate warranty, support and licensing of additional products and services – Multichannel B2C and B2B relationship management – Content marketing – Appropriate relationship management towards the business network and partner structures
Capture value	Possible business operating model include for example: – Pay-per-use – Provision-based models – Subscription

4.3 Fleets of Shared Autonomous Vehicles

4.3.1 Mobility Service Description

Further innovation is based on the convergence of self-driving technology and the aforementioned sharing concepts. These mobility services can be labeled with the tag fleets of shared autonomous vehicles (SAV). Autonomous driving would address many current carsharing and ridesharing barriers, such as the need to travel to access carsharing vehicles. It is believed that autonomous car technology will enable entirely new mobility-on-demand concepts (Thrun 2010; Fagnant and Kockelman 2014). The promise is that robotic vehicles can relocate themselves thus eliminating the rebalancing problem at its core, autonomously reach charging stations if required, and enable system-wide coordination aimed at throughput optimization (Pavone 2015). As described in the previous section, they would free passengers from the task of driving, provide a personal mobility option to people with disabilities or non-drivers, and potentially increase safety. Some advocates claim that autonomous vehicles will dramatically cut travel costs by allowing crossover mobility concepts between on-demand schemes such as free-floating carsharing, dynamic ridesharing and taxi services (Burns et al. 2013). It is argued that this in turn could lead to the reduction in vehicle ownership, parking costs and parking space consumption by cutting the need to own a personal vehicle in favor of a mobility service offered by a shared self-driving taxi (Fagnant and Kockelman 2015; International Transport Forum 2015; Schonberger and Gutmann 2013; Burns et al. 2013). These benefits have recently prompted a number of companies and traditional car manufacturers to further develop the SAV concept, with activities ranging from the design of vehicles specifically tailored to such operations (Motavalli 2010; Induct Technology 2014), to the launch of the first trial programs (Google 2014).

4.3.2 Definition of the Business Model Prototype

Fleets of SAV are the most advanced mobility concept of cooperative autonomous driving. This paradigm enables a plethora of autonomous vehicles to coexist on the roads, autonomously drive in cooperation with each other and provide on-demand mobility services. It is a prospect of an additional transportation mode which would be fully flexible and would offer a door-to-door mobility service. The business strategy would combine all previous prototypes of digital carsharing, digital ridesharing, mobility-on-demand and autonomous vehicles. It would mean a full servitization of cars. Companies pursuing this strategy will act as 'Mobility Service Providers' who deliver fleets of autonomous vehicles to cities. However, to operate on such a market cutting-edge ICT capabilities will be necessary in the form of advanced platform solutions. Therefore, 'Mobility Platform Providers' will also emerge in order to integrate different mobility service providers. Table 3 depicts the

Table 3 Business model prototype 'fleets of shared autonomous vehicles'

P4C business model framework elements	Description
Propose value	Fully flexible on-demand and door-to-door mobility service, also for disabled people and non-drivers
Create value	Provide shared autonomous services by: – Owning or operating a fleet of autonomous cars in different segments (e.g., compact, limousine) – Operating a highly advanced ICT platform for efficient routing depending on the current mobility demand as well as rebalancing the fleet throughout the city perimeter – Ensuring the maintenance of the entire fleet, e.g., everyday service: cleaning and repair Build strategic partnerships with: – Carsharing technology provider – Carsharing platform providers – ICT platform operators (Google, Apple etc.) – Other mobility operators – Public transport operators – Public authorities – Payment operators – Provider of geo-localization and location-based services
Communicate value	Mobility users: – Receive fully flexible on-demand access to shared vehicles – Perform door-to-door journey without changing the mode of transport – All-inclusive charging (e.g., maintenance, insurance, fuel) Much lower mobility costs – Eliminate the first mile/last mile problem and the need for parking – No need for car ownership Municipalities and society: – Fundamentally redefine the mobility system of the city, e.g., combine with public transportation for resolving first/last mile issues – Dramatically increase road safety, accessibility and hence the locational attractiveness – Radically reduce the need for car ownership for the citizens – Redefine public parking space requirements – Potentially reduce automotive emissions by more efficient use of the traffic infrastructure – Completely redesign land-use patterns (e.g., there is no need for parking), establish shared spaces, livable neighborhoods and hence foster compact city development – Be recognized as highly innovative, future-oriented and sustainable city
Convey value	– Mobility service providers responsible for integration, customizing, consulting, implementation and location management (appropriate sizing of the fleet, zoning, relationship management to local municipalities) – Providing fleet access via well designed and user-friendly mobile apps

(continued)

Table 3 (continued)

P4C business model framework elements	Description
	– Multichannel B2C and B2B relationship management – Appropriate management of the business network and partner structures
Capture value	– Pay-per-use operating model, for example, pay-per-minute and/or kilometer – Subscription-based models, e.g., sell mobility packages – Fees for premium services, e.g., no ridesharing, high-class limousine service etc. – Provision-based model for services provided to the passengers during the journey – Freemium models, e.g., get a ride for free to a commercial institution (e.g., shopping mall) or accept advertisement during the journey (YouTube-like) – Advertisement

business model prototype for operators of fleets of shared autonomous vehicles in more detail.

5 Conclusion and Key Learnings

Business model creation and innovation is crucial for a high diffusion of any new technology, since the necessary prerequisite for the industry to provide specific innovative applications of the new technology is to gain profits out of it. Commercial companies will contribute and commit to the development and implementation of system-level innovations in urban mobility only if a fair return on investment is assured to commensurate with the financial risks taken. Hence, technology innovation and business model innovation are strongly linked to each other (Abdelkafi et al. 2013). From this perspective, the authors of this contribution have drawn their attention to the sector of automobility. They have showcased current developments in car- and ridesharing (cases smexx and TwoGo by SAP). Furthermore, they have developed possible mobility concepts and associated innovations in business models based on car digitization and automation.

The five ‘ready-for-implementation’ prototypes of business models are based on a range of different innovative mobility concepts and digital technologies. They constitute innovative ideas reflecting how to commercialize and overcome the inefficiencies associated with private car ownership and usage. With that the authors create a body of knowledge and provide a source of information regarding the development and implementation of digital business models for shared automobility services that can be integrated into a highly efficient urban mobility system of the future.

It is thought that the further development and deployment of these emerging technologies for personal urban mobility bears enormous benefits for the society. For example, autonomous vehicles promise safer and more comfortable personal transportation based on cars at lower insurance costs and better fuel-efficiency. The benefits could be much higher by enabling entirely new mobility concepts based on the hybridization of mobility services such as: carsharing, ridesharing and taxi services. Along with an efficient public transportation system and increased slow modes of transportation, such systems would aim at improving transportation security, radically shifting resource efficiencies and substantially reducing gas emissions (Sweeting and Winfield 2012).

However, these rapid technological advancements and the increased commercial interest in such on-demand mobility systems have started eager discussions about the design of such mobility systems and their potential societal value. Key questions that are addressed[3] encompass for example: How many autonomous vehicles would be needed to achieve a certain quality of service? What would be the total cost of their operation? Who would operate them and what are the regulatory requirements? Would such mobility systems decrease or rather increase the congestion in cities? Would such solutions be technologically feasible, economically viable, environmentally sustainable, and socially and politically acceptable? The authors of this contribution regard these challenges as critical for further research and development in this area. They also expect that this will encourage academic researchers and business practitioners to develop dedicated research agendas in order to provide viable answers in the near future.

Key Learnings

- The difference between the private car ownership paradigm and the product-to-service (servitization) approach has been shown. The gap is filled by developing the understanding about pay-for-use mobility concepts such as carsharing and ridesharing.
- There is an observable convergence between digital technologies, shared mobility patterns as well as recent advancements in the automation of cars, which can lead to a range of innovative mobility concepts and new business models for the automobility.
- One of such visionary concept are fleets of shared autonomous vehicles. Such systems will have the capacity to considerably raise the efficiency of car-usage.
- These innovation areas are explored by new actors, such as ICT companies. Hence, the automotive sector is required to develop appropriate strategies and partnerships in order to be well equipped for the challenges ahead.

[3]For further discussions refer to the doctoral thesis *'Paradigm Shift in Urban Mobility: Towards Factor 10 of Automobility'* (Janasz 2016 forthcoming).

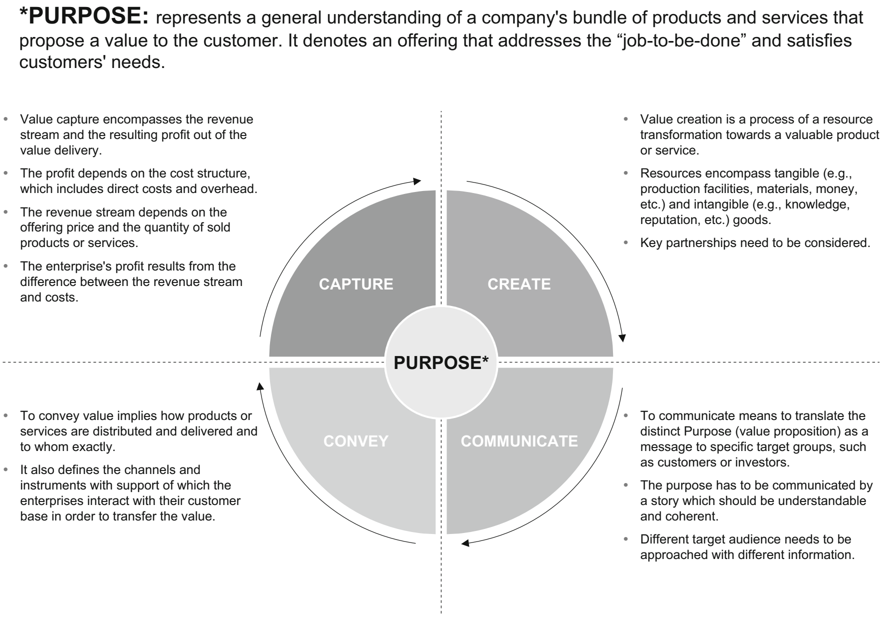
Appendix 1: Three General Archetypes of Business Models for Innovative Mobility Systems (Based on Lerner et al. 2012)

Business model archetypes	Description
Mobility service platform provider	This archetype describes a provider of single point of access for mobility and cross services, such as: identification, information, booking and payment. It requires the involvement of many actors: policymakers, public transport operators, banks and payment firms, telecommunication companies, and ICT suppliers. The latter ones are crucial since this archetype is based on the generation, processing and transmission of significant amounts of data and on high penetration rates within the society. An actor adopting a business model based on this archetype provides a medium for any user who seeks to receive travel information, plan a journey, make a booking and pay for the journey. His challenge is to aggregate, source and contract the underlying third-party services, such as: operators of parking lots, public transportation, bike-sharing schemes or providers of location-based services. The providers of such a platform aim at reaching as many users as possible, since the revenue stream would result from partner transactions, advertising or interest income from e-wallets of the customers
Mobility chain integrator	Integrators are companies who choose to do it all themselves. They distinguish themselves by a high level of vertical integration and by performing almost all value adding activities in-house. This business model archetype focuses on the integration of the entire mobility value chain. There are two possible characteristics: B2C and B2B. The B2C approach aims at delivering integrated mobility services for end costumers, i.e., services which provide seamless and multimodal journey experience. The B2C integrator offers a personalized journey from A to B, whatever modal mix it requires. Providing integrated and multimodal mobility solutions at 'turn-key basis' for cities and mobility service providers would be the B2B approach. The B2B integrator could include parking infrastructure, charging infrastructure, automated fare collection, bike-sharing scheme, city buses, financial services, mobility planning etc. Car manufacturers are a good example for a high level of vertical integration, albeit the level of this integration has decreased considerably in recent times
Mobility products and service provider	This archetype refers to many facets of urban mobility ranging from mobility offerings e.g., car- or bike-sharing, through technology providers such as key-less access for cars, to travel planning and information. Although, multimodal connectivity and networking is not the key aspect in this business approach, the mobility products and service providers are the prerequisite for the integration and multimodality in cities. In principle, such a supplier delivers standalone solutions to municipal administrations or to mobility chain integrators. A prominent example of this kind of business model in urban mobility is carsharing and carpooling mobility services. As the present contribution chiefly relates to

(continued)

Business model archetypes	Description
	overcoming the inefficiencies of car usage in cities, in the next section the author will delineate relevant business models in these two areas, as not all business models for carsharing and carpooling services are created equally

Appendix 2: The P4C Business Model Framework Applied for the Analysis of Case Studies (Diagram by Authors)



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Tomasz Janasz is a business administration graduate from the University of Hamburg (2007 class). Tomasz is a Ph.D.-candidate with his research thesis on innovative technologies and new business models for the future of urban mobility at the Schumpeter School of Business and Economics, University of Wuppertal. For his research he was awarded the Swiss Electric Mobility Award from Touring Club Suisse (TCS) in 2013 and the Best Talk Award at 'Science: Polish Perspectives 2015' at Cambridge University, UK. Tomasz has been with SAP Business Transformation Services since 2008. He acts a strategic advisor for business innovation and transformation. He co-developed the Business Transformation Management Methodology (BTM^2), the Digital Capability Framework and SAP's Cloud Transformation Services. He is a certified Global Business Transformation Master (2014).

Uwe Schneidewind is President and Chief Research Executive of the Wuppertal Institute for Climate, Environment and Energy as well as Professor for Sustainable Transition Management at the University of Wuppertal. He studied Business Administration at the University of Cologne. Ph.D. thesis (1995) and habilitation thesis (1998) on strategic environmental management issues and the role of enterprises in societal transformation processes at the University of St. Gallen, Switzerland. Professorship for Business Administration at the University of Oldenburg (1998–2010) and President of the University (2004–2008).

What Co-Innovation Can Mean for Digital Business Transformation: Sharing and Managing Risk to Achieve IT Business Innovation

Cosmin Condea, David Cruickshank, and Pascal Hagedorn

Abstract There are viable and compelling options to tackle some of the most difficult business problems, particularly in terms of technology change, through exploring co-innovated solutions between a firm and its leading suppliers and business partners. We suggest that co-innovation is a strong enabler for digital business transformation by sharing three exemplary SAP Co-Innovation Lab projects that are meant to support broader business transformation initiatives. The first case concerns the development of an innovative responsive mobile solution for engineering constructions and operations. The second case describes an Augmented Reality solution for innovatively enhancing maintenance operations in the aerospace sector. The third case combines a prescriptive maintenance solution integrated into a technology platform with extensive data analysis to deliver critical metrics and key performance indicators. The insights gleaned from successful execution of these projects should serve useful to those who are pursuing digital business transformation through innovation.

1 Reinvent to Succeed: The Need for Digital Transformation

While it has perhaps become common knowledge among innovative leaders and implementers that a company must innovate or die; like anything that matters, it is something often easier said than realized. This holds true for all types of companies,

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C. Condea
Center for Digital Leadership, SAP (Switzerland) Inc., Regensdorf, Switzerland
e-mail: cosmin.condea@sap.com

D. Cruickshank
Strategy and Operations, SAP Co-Innovation Lab, SAP Labs LLC, Palo Alto, CA, USA
e-mail: david.cruickshank@sap.com

P. Hagedorn (✉)
Co-Innovation Lab Switzerland, SAP (Switzerland) Inc., Regensdorf, Switzerland
e-mail: pascal.hagedorn@sap.com

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not simply established firms at risk of encountering Christiansen's 'innovator's dilemma' (Christensen 2011), according to which they will reject innovations based on the assumption that customers cannot currently use them, thus allowing these ideas with their great potential to go to waste. We now live in times during which these large firms with vast resources are equally capable of unleashing disruptive innovation through well executed acquisitions as well as through strategic partnerships. These more established companies can draw immense benefit tapping into innovation networks lying beyond a firm's walls as an approach to achieving 'Digital Business Transformation', embracing what can be derived from cloud computing, devices, data and networks.

Digital transformation is fundamentally changing every industry. Just as with consumers, everyone in the business world is in hot pursuit of benefits they derive from the same ease of digital consumption. Businesses, in order to remain relevant, must be capable of selling, buying and consuming software services with minimal human interaction.

True digital transformation is a significant shift now touching multiple industries and has moved far beyond simply digitizing processes and using computers and eliminating the use of paper. Services delivered through software must be agile and be able to adapt to changing customer and market needs in an instant. For a typical firm, this changes everything from the way software is developed to the way it goes to market. It further impacts the way software is sold and supported. In its complete form, digital transformation guides thinking. This is true for the firm's board, its management and employees, as well as its suppliers and partners. This is core to digital transformation.

Yet large or small, growing and continuously profitable, companies all need innovation as the means to progress towards successful digital transformation. A McKinsey study estimates that 70 % of all transformation programs fail (Kitching and Roy 2013). Despite this, companies will accept the risk and make attempts at managing the effort towards a successful outcome. It is the advice many consultants give too, that across multiple companywide transformation projects, it is fundamental to do more than merely migrate from one technology platform to another or perform business process re-engineering. Innovation at the technology level is meant to enable an entirely new future state that could include new business models and cultural change across the entire organization.

The purpose of this paper is to share with the reader that there are viable and compelling options for tackling some of the most difficult business problems, mainly in terms of a technology change, through exploring co-innovated solutions. In particular, in the emerging digital ecosystems there are without question radically new ways of thinking about business and innovation. Our contribution shared here showcases real cases in this respect. We share three exemplary SAP Co-Innovation Lab (COIL) projects, each with outcomes meant to contribute to broader business transformation initiatives. The co-innovation insights gleaned from successful execution of these projects serves those charged with pursuing digital business transformation through innovation. When embarking upon transforming into a full digital business, discovering how to leverage co-innovation to accelerate the future state and mitigate risk is worth serious consideration.

2 Formation of Co-Innovation Approaches

A multitude of innovation approaches abound in nearly every industry. Both established firms and fledgling startups alike deliver a rich mixture of disruptive and incremental innovation. For any company an execution plan is necessary to get an idea transformed into a successful implementation of innovative new technologies and processes. Just how a firm makes this happen can take many potential paths, any of which might help achieve the desired outcome. Some startups can become part of an incubator to take advantage of pooled resources either for some fee or for an early stake in the company. Others may simply hire or outsource discrete talent to augment an ability to successfully and rapidly innovate. Established firms may acquire technology to become part of their existing product portfolio and core competencies as a way of accelerating bringing innovation to its customers. Those firms capable of effectively creating and developing a diverse and vibrant ecosystem extend their innovation capacity even further through co-innovation with the firms and institutions which comprise it. The ecosystem concept captures the collaborative arrangements where firms amalgamate their individual offerings into a coherent, customer-facing solution (Adner and Kapoor 2010; Iansiti and Levien 2004). A platform of co-innovation services is key to enabling project teams from several participating partner firms to effectively innovate together. Platform-based ecosystems generally revolve around a core service, tool or technology allowing the functionality of the platform's products and services to be enhanced or extended by participants from the ecosystem (Boudreau 2007, 2010; Williamson and De Meyer 2012; Gawer and Cusumano 2008; Gawer 2011). In the case of the SAP COIL it can be viewed as one of several ways in which SAP connects with, engages and can interact with its ecosystem. It is, by design, meant to enable and to accelerate more innovation.

Co-innovation project outcomes aim to create or contribute to the formation of co-innovated business solutions. Managers tasked with various dimensions of what a company must do to become completely digital may find this co-innovation approach has attractive attributes, contributing both to accelerating innovation and managing innovation risks.

Co-innovation in practice demonstrates a firm's deliberate interest in extending its innovation capacity to include an external view of experts, in order to make end results implicitly more innovative. Doing so additionally underscores a willingness to embrace outside ideas from a large and diverse ecosystem and to encourage the ability to exercise and orchestrate dynamic capabilities of the ecosystem's firms.

Co-innovation extends key knowledge and capabilities. It is a viable way to now accelerate creating and delivering innovative solutions designed to meet technology and business requirements regardless of the industry. Collaboration creates an opportunity to leverage or combine resources among partners engaged in co-innovation initiatives and can help participating firms in reaching new industries and markets of interest. One way to observe this is in the number of partners that pursue further phases of the project work or connect with other COIL project teams and discover opportunity to work together on something new. Another significant benefit to the co-innovating firms is the rich tacit knowledge exchange that occurs among project participants and the fact that co-innovation projects often become catalysts for spawning entirely new innovation projects.

Over the last decade, a practice known as 'open innovation' emerged where the active combination of knowledge with and from the outside world is key (Chesbrough et al. 2006). Companies pursuing an open innovation strategy can find it requires discipline to diagnose fields in which the firm can create the most economic value (Tuff and Jonash 2009). We characterize Co-Innovation as one approach to practicing open innovation. From the view of the SAP Co-Innovation Lab we find an established purpose built environment and platform enabling participants to contribute equally or to have equal opportunity to capture the spoils from the outcome. One primary tenet of open innovation upheld in most co-innovation projects, lies in how ideas for new business solutions frequently originate from an outside ecosystem. These external ideas then become worked and managed by a firm and its partner(s) to deliver a co-innovated solution.

What we describe here and what underscores our three use cases is how providing a co-innovation-as-a-service platform enables co-innovation between SAP and partners on an operational level. This allows one project team to immediately begin focusing upon the project's innovation goals and expected outcome while the other team is searching and sourcing required skills or physical resources to make a project operational. To have this dimension and its details abstracted away simplifies how the team works. A scalable and extensible way to operationalize co-innovation project work reveals a productive way to prioritize and manage the technological complexities and the risk inherent in solving tough business problems. Co-innovation invariably stands as a viable way of solving complex problems that a single firm cannot tackle independently. Whenever the focal point of risk lies on successful enablement of new technologies, a co-innovation approach can greatly support firms. Managers charged with some dimension of digital transformation for their firm may want to consider how to employ co-innovation techniques that orchestrate and integrate components sourced from multiple equipment and service providers.

3 SAP Co-Innovation Lab (COIL)

The SAP COIL is a well-distributed network of SAP Product and Innovation Labs found in 13 geographically dispersed yet relevant locations with the express purpose of helping harness the SAP ecosystem and successfully enable high value co-innovated business solutions (Fig. 1). SAP, as well as its customers and its partners, all derive benefit from co-innovation. For customers, it can mean

Fig. 1 The global SAP Co-Innovation Lab Network

solving problems faster and increasing business agility. For partners, it creates new business and fosters growth, drives brand visibility and helps build alliances. These alliance formations are of value to SAP as is the ability to create and expand innovation. It keeps SAP continuously plugged into the new.

3.1 Co-Innovation-as-a-Service

COIL comprises an integrated set of capabilities and methods providing the space, private cloud infrastructure, a legal framework, plus operations expertise to support a broad portfolio of co-innovation project work. The aggregation of all these services forms the Co-Innovation Enablement Platform (CEP), which is managed and operated by the COIL operations and project management team to support concurrent COIL projects and events (see Fig. 2). This section describes the elements of CEP in more detail.

3.1.1 Services

- *Infrastructure* relates to software, hardware and networking equipment organized and standardized to automatically create and manage physical and virtualized co-innovation workspaces to support multiple concurrent projects on a mixed SAP and non-SAP landscape.
- *Project management* includes defining a project's scope, objectives and processes for collaboration and managerial resources to facilitate the project's execution. On top of this, consulting during co-innovating, serving with business

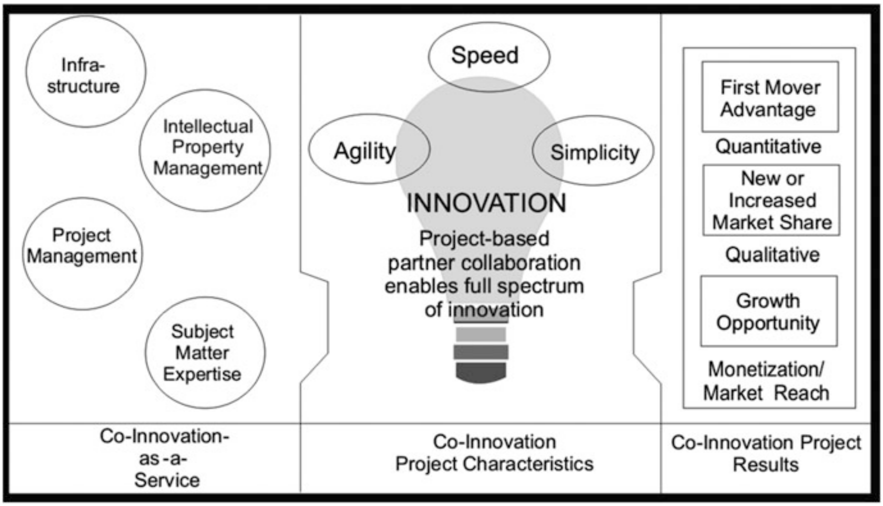

Fig. 2 Co-innovation enablement platform at SAP COIL

development activities and showcasing the result to a wide audience are additional measures to support.

- *Subject matter expertise* includes the gathering of knowledge unique to the software, systems, and technologies used within the project. SAP COIL brokers the missing knowledge from internal sources or from within the SAP ecosystem.
- *Intellectual property management* dedicates legal resources for specifying contract provisions aimed at promoting collaboration and trust among parties by means of bilateral agreements enabling co-innovation.

3.1.2 Defining Characteristics

As Fig. 2 further indicates, co-innovation projects can often be characterized by agility, speed and simplicity. Agility is achieved through the collective competencies and collaboration as well as by dynamic adaptation to missing knowledge via the knowledge broker organizing enablement sessions. Speed is achieved by focusing on the use case and targeting the key challenges to either succeed or fail fast. An easily adaptable legal framework and operational process to execute the co-innovation project contributes to simplicity in operationalizing a co-innovation project.

3.1.3 Co-Innovation Results

Results observed from firms engaged in forming co-innovated business solutions include:

- First-mover advantage, which is the result of a disruptive innovation that no one before has ever delivered, thus ensuring a unique selling point. In existing markets, it can be either an increase in the market share or a complete new entry into a net new market for the partner.
- An opportunity for growth of human resources or other assets which help strengthen the firm.

Further qualitative results include rich collaboration activities while hosting a series of seminars and webinars, thought leadership forums, and onsite and online collaborations with SAP and other industry leaders. The lab offers high-impact demonstrations and solution showcases with onsite and online access. Such examples demonstrate how the SAP COIL provides a completely new type of collaboration platform for the industry's top minds to work together on the most pressing business challenges customers face in the digital era.

3.2 COIL Process

The SAP COIL runs co-innovation projects based upon a proven process (see Fig. 3) separated into three consecutive phases, it runs similarly to the one described by Patsch and Zerfass (2013).

- *Ideation Phase*. This phase includes the identification of key project stakeholders sharing a single vision and an interest in a complementary result. The consultative capabilities of SAP COIL fuse innovation process experience and a proven co-innovation methodology to help project stakeholders elicit requirements and deliver a complete co-innovated business solution.
- *Execution phase*. This phase begins with provisioning the project landscape and providing enablement sessions for project teams. Knowledge brokering plays an important role in solving implementation challenges. Simpler problems are solved by specialists found within SAP while more complex problems are solved in a project-team effort finding complementary external partners for the missing knowledge.

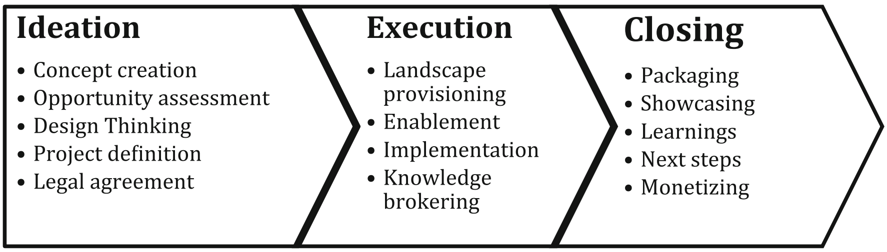

Fig. 3 Three phases of a co-innovation project at SAP Global COIL Network

- *Closing phase*. While project outcomes can vary widely in most cases, the results contribute to a joint or separate go-to-market endeavor or serve as technical proof of concept. The SAP COIL was designed not only to enable successful co-innovation but also to showcase a co-innovated solution and help introduce it to the market. In other instances it may bear out the proof required for a partner to go to market with SAP® solutions.

4 Co-Innovation in Action: Three Exemplary Cases

The three case studies presented illustrate the degree of co-innovation applied to deliver outcomes directly applicable to successful business transformation.

Case 1 describes the pursuit of a co-innovated solution directed to the engineering and construction industry. The foundational idea for creating mobile applications for this industry originate with Element Five endorsed from within SAP's own Industry Business Unit (IBU) for engineering and construction. Its co-innovation focus is to more fully integrate with SAP HANA® as a way of ingesting applicable structured and unstructured data (heavy equipment sensor data, weather forecasts and geo-location to provide a real situational awareness and on-the-fly analytics) all designed to better automate the day-to-day tasks for general contractors and provide insightful decision support. Additionally, the project evaluates the ability to reliably deliver this innovative solution from the SAP HANA Cloud Platform (HCP).

Case 2 zeroes in on Augmented Reality. This case was chosen for its combination of digitization (digital product design and integration into ERP) and digitalization (offering new additional services based on the new digital capabilities) in a co-innovation project. The project scope grew over three consecutive phases—and at the end of each phase a technical proof point was established.

Case 3, additionally to this, centers upon the dimensions of digital transformation through developing a bundled integration of capabilities, so as to create an industry specific prescriptive analytics solution that collects, aggregates and analyzes machine data in order to effectively render a digital profile from sensor data to reliably determine what is seen as normal behavior for an operational asset. From this profile, the solution not only predicts when and how machines will fail but also automates actions to improve overall operational integrity.

4.1 Case 1: Element Five, Construction Industry Solution

This COIL project's primary objective has been to enable SAP partner Element Five to develop a responsive mobile/web solution for engineering, construction and operations (EC&O) and for related industries having a field workforce as well as equipment and a need to capture, assign, and allocate necessary information at each physical location and also to send the information to a back-end for processing, analysis and documentation.

4.1.1 Company

Element Five's core business is providing software solutions primarily on mobile and in the form of cloud solutions that connect and enhance SAP's ERP, CRM, HCM offerings. Its solution can be deployed on premise and in the cloud.

4.1.2 Situation Faced

Digital transformation is beginning to effect and change every industry. To a casual observer, the world of construction and its use of technology might only bring to mind how workers like carpenters, welders, electricians, plumbers or masons make use of power tools and heavy machinery. Yet as the project team connected and learned from general contractors in the business, it was clear that how these businesses run, especially at any scale, is in real need of digital transformation. The modern general contractor can now barely rely on older methods of managing activities at one extra construction site and the need to communicate with and manage multiple subcontractors. Even the most skilled and experienced can no longer rely on clipboards, paper and memory to ensure that hundreds of tasks and workflows stay on track. More recently, software solutions have emerged that aim at providing better organization, tracking and decision support. Yet, the project team observed that the demand of the market is driving the industry to become completely digital. An all-digital construction firm can expect to continuously provide required capabilities and decision support in real time with information beyond things like whether or not a laborer has arrived on time or called in sick, or if a load of lumber or a spool of copper wire was delivered so that a new task can start. Data can be captured electronically—for instance, the geo-location of all who may be working in an environment that is hazardous, posing a risk to worker safety. Furthermore, one could also enable obtaining accurate prediction about the possible failure of some piece of heavy machinery. Today's general contractor manages a spectrum of simple and complex tasks that can span multiple projects and locations, drawing benefit from new technologies and capabilities now available. Because population and economic trends drive people into city centers, significant growth of that industry over the next decade is expected.

4.1.3 Actions Taken

The core co-innovation team composed of SAP and Element Five applied Design Thinking principles during the ideation portion of phase two that included identifying and more fully understanding the problem as perceived by the key persona of

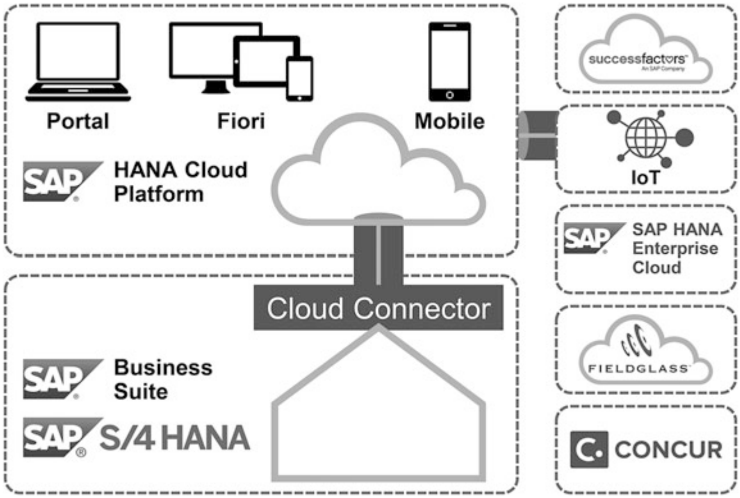

Fig. 4 Project use case architecture

a general contractor superintendent: How to effectively manage workflows driven by various subcontractors and suppliers. Additional input to the core requirements of this industry were provided by the SAP Engineering and Construction IBU.

4.1.4 Results

As the architecture shows in Fig. 4, this solution is designed to help companies in EC&O and other resource intensive industries with faster access to estimates and actuals to improve project execution. The solution was realized as a solution extension to SAP's Digital Core on the SAP HCP with the following capabilities, namely to:

- Track and monitor the utilization of people and equipment.
- Collaborate with and among partners, such as suppliers and contractors.
- Utilize Big Data such as geospatial and IoT data (e.g., equipment sensor data for telematics).

From a business transformation perspective, Element Five now anticipates that through this co-innovation effort, the way solutions are built and priced will be very different and a catalyst for driving a very satisfied end-user community, without the customer needing to wait for huge budget approvals or getting the buy-in from multiple stakeholders.

4.1.5 Lessons Learned

The Design Thinking workshop helped the team capture a day in the life of a superintendent; a storyboard emerged from it, ideally illustrating the core activities and the pain points associated with them. This Design Thinking session, the problem, persona and storyboard were sufficiently validated from an actual customer participation. This became an immense aid to accelerating how Element Five and SAP could build and deliver a game changing co-innovated solution to the EC&O industry that equally delivers a must-have customer experience.

4.2 Case 2: Augmented Reality: New Services through Digitalization

This case comes from Central Europe and relates to the high-tech industry. It explains an end-to-end integration from a mobile device using existing 3D models within Augmented Reality connected to an SAP® ERP ECC, emphasizing digitization and digitalization.

4.2.1 Company

allvisual AG, a Swiss startup company, is one of the partners that implemented the core PLM and ERP processes for a high-tech, aviation manufacturer, including the CAD integration. They have expertise in 3D product and process visualization based on SAP 3D Visual Enterprise, which is used within various scenarios along the entire product life cycle shown in Fig. 5. The product life cycle reaches from research and development to manufacturing, from marketing to sales and covers customer services as well and highlights that the complete process is digital.

4.2.2 Situation Faced

The customer of allvisual AG decided to produce a new product in a highly authority-regulated market and to banter with the handful of giants in this area with a complete digital process to offer new services to the products operators. They designed the product entirely with CAD and integrated the 3D models within SAP ERP ECC to connect all information on the product's life cycle with the item and with the material number. The 3D visualization and the complete digitalization of their product and processes leads to tremendous money savings and new additional scalable services.

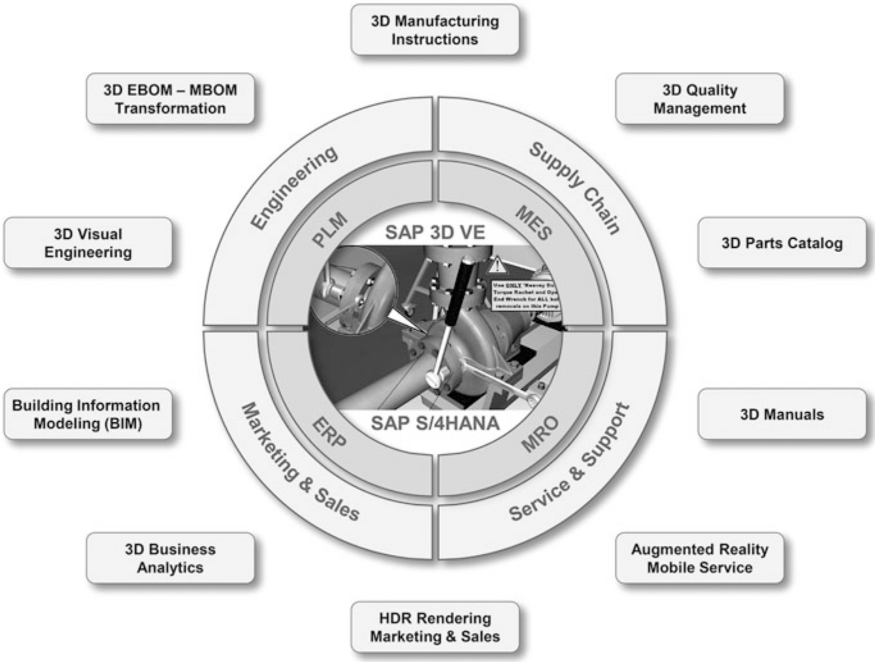

Fig. 5 SAP 3D visual enterprise—benefits for all lines of business

4.2.3 Actions Taken

This co-innovation project was special to its concept creation, opportunity assessment and project definition. Two other partners have progressively been involved in the following phases of the co-innovation project, contributing their special expertise as follows: (1) Orianda Solutions AG, with their know-how in mobile solution apps supporting maintenance repair and overhaul processes; and (2) Wikitude, providing their Augmented Reality library using specific features of mobile devices. With all parties a bilateral legal agreement was signed to protect each other's intellectual property and to regulate access to the system landscape (*legal agreement*).

Phase 1: Historically, the initiation of this project was indirectly started with Wikitude contacting SAP COIL in Singapore to discuss a potential co-innovation project. The first proof point was to bring their Augmented Reality solution together with SAP mobile solution. When this proof point was successfully passed, a nice inspiring mobile app was finished, visualizing business data using Augmented Reality which is received from a SAP ERP system. This app was presented to various parties internally and externally to generate new ideas.

Phase 2: Shortly thereafter, allvisual AG saw the mobile app and immediately understood what this Augmented Reality technology meant to their business and

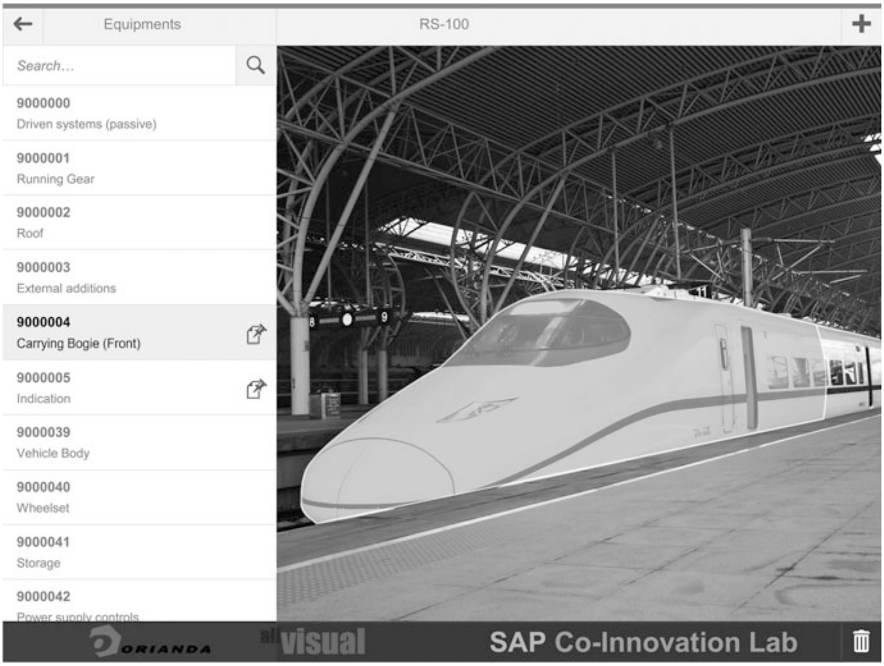

Fig. 6 Screenshot of the mobile app (applied to another industry)

another proof point was defined: This time the challenge was to bring a SAP Visual Enterprise 3D-model onto a mobile app using the Wikitude Augmented Reality library. After this positive second phase, all partners and customer got together to decide on a Design Thinking workshop so as to define a complete end-to-end process.

Phase 3: During the third implementation phase (*implementation*), the project result was a proof of concept to visualize these 3D objects and the 'step-by-step' maintenance instructions within a mobile app. By using this, support tickets can be generated and operational support provided to the operators and technicians, similar to Fig. 6. Augmented Reality offers the possibility to embed context-sensitive information on the display which significantly enhances the level of service during the operation and maintenance process.

allvisual AG was able to concentrate on their special expertise in the PLM related business processes and data models supporting 3D visualization in the context of the digital product, industry 4.0 and the IoT within the medical, machinery, automotive, utility and aerospace industries. In the meantime, the SAP COIL also connected with the SAP Visual Enterprise Development group to answer questions related to the project (*knowledge brokering*). The know-how offered by Orianda Solution AG complemented the scenario to build an Apache Cordova cross platform SAP Fiori® mobile app using Wikitude's Augmented Reality library and connecting into the SAP ERP ECC over the SAP Mobile Platform to use its offered

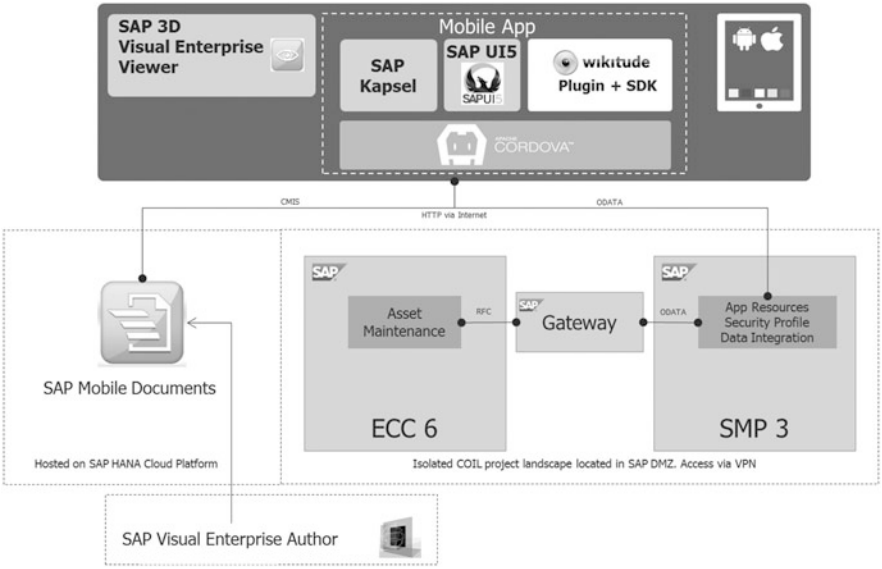

Fig. 7 Project system landscape

features. Orianda received some knowledge transfer on how to use the SAP Mobile Platform (*enablement*). The COIL provided the system landscape shown in Fig. 7 (*landscape provisioning*).

4.2.4 Results

One outcome is a mobile app which is used to stimulate discussions for following consulting projects. The project outcome uses many independent technologies to realize an end-to-end process, many more than one partner could handle alone due to lack of knowledge and expertise. Also noteworthy is the time saved by working together. Because of this, the achieved outcome is perceived as extremely positive by the customer and project participants and is in total more than the sum of the individual parts. The app helped allvisual AG break into the healthcare and machinery market and find new customers to support and enable their digital transformation strategy (*packaging/showcasing*).

The business innovation and transformation lies in the complete and seamless digital integrated process, which enables full transparency along the value chain.

The major benefit is that existing digital documents can be used in new service offerings, adding an additional and more accurate business process support. This is achieved through complete digitization and digitalization.

4.2.5 Lessons Learned

Being lucky enough to find the complementary partners might be a risk and is quite unpredictable, but generally everyone has a huge network of heterogeneous partners to search for the missing and complementary 'pieces'. Having had a demonstrator to showcase the result of each phase helped understand the planned innovation—and also motivated the new party to participate. Teaming up in this constellation was really productive and the outcome was well perceived externally. Further, it showed that a proof of concept can stimulate innovation and find its application in other settings than initially planned. Concretely, the sensors of the standard hardware proved to be inadequate for 3D object recognition, due to their current limitation in lacking a built-in depth sensor (*learnings*). The outcome was transferred nonetheless to other industries, like medical devices, where such 3D object recognition is not needed (*next steps/monetizing*).

4.3 Case 3: Mtell/Rolta: Predictive Maintenance with IoT and SAP HANA®

This particular COIL project is a confluence of three companies, each with its own individual technology contributions, working together in a lab to form up the respective technologies as a way of rendering a more complete solution—of interest and use to multiple personas found in a midstream oil and gas operation. The project's chief goal was to showcase for the industry how co-innovation improves operational integrity for owner-operators of industrial manufacturing and production businesses. It is the sum of three technologies and solutions that is meant to do more than what the three firms alone can do in lowering risk and offering greater operation rewards to the end customer. While the idea to pursue this as a co-innovation project originates from within the SAP Oil & Gas IBU, each participant contributed software and ideas, originating with them to the co-innovation project goals and objectives. From the combined industry experience and subject-matter expertise sitting within the project team, it collectively influenced and shaped the original integrated bundle idea as an industry solution, including how it could be deployed.

Due to a mix of resource constraints, time pressure, and competitive considerations, the decision was taken within the Oil & Gas IBU Operations Integrity team to pursue a co-innovated approach to accelerate bringing IoT-based innovation to the industry, while paying close attention to the managing of the risk, associated with how to accurately draw valuable business insights from machine data.

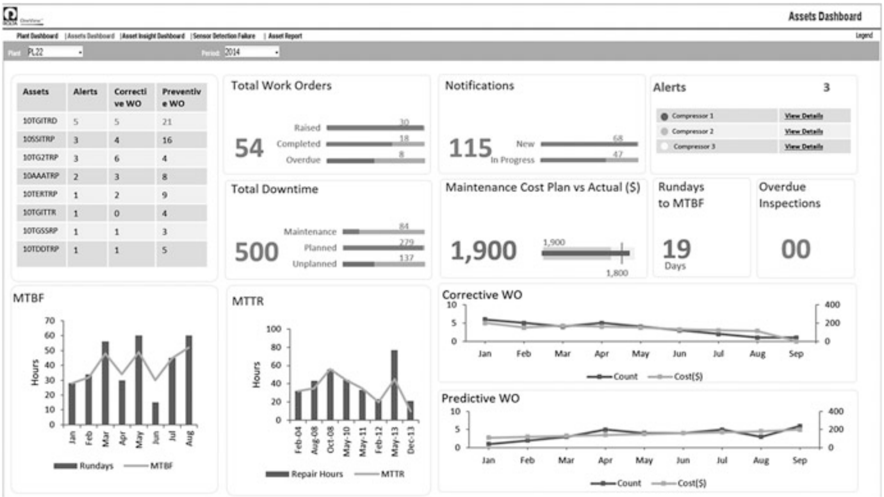

Fig. 8 Dashboard view of the reliability engineer

4.3.1 Company

In this case study, Mtell brings its prescriptive maintenance solution, based on industrialized machine learning, to detect when and how equipment begins to degrade. It then additionally prescribes corrective action to avoid or mitigate failure. These solution capabilities are complementary to SAP. SAP affords asset integrity events to aid in precise pattern recognition, and its SAP HANA in-memory database platform assures that the intensive computations occur with lightning speed and improved accuracy to minimize risk; Mtell brings a key operational integrity component to the SAP portfolio.

Rolta brings to this project extensive data analysis knowledge, and a capability for delivery of critical metrics and key performance indicators, to managers and executives responsible for operational decisions. It does so to ensure safe, clean operations, at maximum profitability.

Through SAP Design Thinking workshops the team discovered how to develop key industry personas of those who interact with the solution. Rolta's advanced data analysis and dashboard technology fulfilled requirements that could not be fully met using either Mtell or SAP visualization capabilities. Through the persona development work, the project team strove to identify the right end user in order to deliver the right visualization and immediate access to actionable insights. This is visualized in Fig. 8.

Consequently, extended groups of personnel, including higher-level executives, are now able to view a complete picture of present and future asset health and all operational consequences.

4.3.2 Situation Faced

There is a critical need in the oil and gas industry to revise today's maintenance procedures as a means to fill the huge lost profitability gap caused by poor equipment reliability. The way maintenance is being done today is failing the industry. Every maintenance strategy to date, even the very latest reliability-centered maintenance (RCM), produces a 'game plan' that instructs the operation to focus on 'when' to inspect and service; based on schedule, usage, and risk. Despite the studies that prove that equipment still fails on a time-random basis, and that intrusive inspections can actually cause more problems than they solve, the people behavior and the business process using a limited technology still persists. It is this lack of integration and visibility into asset management processes that leads to a low return on assets, high costs for maintenance a and sub-optimal production yield, which drives the call for better, more accurate asset intelligence made possible from digital transformation.

The SAP IBU and its Operations Integrity team determined there was a gap that SAP with its ecosystem could readily address: the need to co-innovate an industry specific IoT-enabled solution to solve this serious industry problem.

4.3.3 Results

This Prescriptive Analytics project was formed to create an integrated and bundled co-innovated SAP Business Industry Solution to facilitate better decision-making by predicting the behavior of inline assets, by correlating historical and real-time data, to maximize operational effectiveness without compromising compliance, safety, and the environment.

The project team considered what was fundamental to implementing Prescriptive Maintenance in a way that makes it practical. With Mtell on SAP HANA, three things became possible:

1. Autonomous Agents.
2. No more false alarms (false positives).
3. Transfer of all behaviors to other assets.

Using a customer dataset, the project team built up an Mtell on SAP HANA instance in the lab to then ingest and analyze data representing 38 pumps (14 types), each comprising a mixed array of 9–24 different sensors (temperature, pressure, flow, vibration, amps), all from a single location, and all used to build up normal behavior profiles for every asset. Additionally sourced were 703 cross-referenced work notifications and failure events from the same time as the collected sensor data, all from SAP's plant maintenance functions.

In the COIL lab, Mtell on HANA classified the data as 11 problem codes, 89 breakdowns, finding US$1.6 M in maintenance costs on top of 10 failures, generated 38 hidden failure agents, created 30 failure agents and discovered 100 anomalies.

The combined solution from the three collaborating companies yield the following dimensions of the integrated solution—all shaped from three perspectives:

1. The framework for hosting plus accelerating data gathering and processing.
2. The product and technology basis for accurately predicting likely machine health and offering guidance to change those outcomes.
3. The ability to advise and present to different personnel in diverse roles the status and effects upon their roles and accountabilities.

The synergistic nature of the three brings a comprehensive solution that is greater than the sum of the parts. The output from this initial project clearly demonstrated the value of such an integrated bundle of capabilities and has since spawned proof-of-concept work with multiple oil and gas firms, and it has put into motion follow-on COIL project work to extend the solution, set with more capabilities that target needs found across upstream, midstream and downstream oil and gas operations.

4.3.4 Lessons Learned

There are critical aspects of the COIL project methodology. Indeed, working together with a customer on a real issue brings significant authenticity. The problem is real, the customer is involved directly, and the immediate feedback improves understanding and consequently the efficacy of the joint solution. The intimate working relationship between the parties also affords relationship building that improves all future business between the partners. From an individual perspective, each party accepts that it must accentuate its own core focus to improve its offering to the combined solution, and understands it need not develop every aspect when such functionality is within the purview of a partner offering.

While the project has driven and continues to drive benefits otherwise difficult to achieve, co-innovation efforts can be challenging; especially for smaller partners. Subsequently some top concerns do surface for partners in the pursuit of a co-innovation project:

- The cost burden of the COIL project to a small company.
- Bureaucracy issues and politics surrounding very large, complex and matrixed organizations.
- The time it takes, and the time already elapsed.
- Perceptions of others inside and outside of the project.
- Turning the results of the project into improved revenues.

Nonetheless, it becomes understood pragmatically by all the project participants that the time, skills, and effort to pursue the target goals and objectives of the co-innovation project are likely to be untenable under current market conditions. Only a joint partnership shares the load and accelerates the potential for market penetration of a best-in-class solution. Progress made in the project to date has already established arguments for continuing a second phase of the project work to drive higher degrees of integration with SAP HANA, and to forge an ability to deliver the integrated solution for the SAP HANA Cloud Platform.

5 Conclusion and Key Learnings

The similarity across each of our three co-innovation projects is the adoption of the co-innovation approach described above. Unique to each is how the embodiment and deepness of the services of each use case varies. Worldwide, firms must actively seek digital business transformation, which in turn means embracing technology to support an ever increasing number of connected devices, together with the immense volume and variety of structured and unstructured data sourced from these devices, from enterprise systems, social networks, etc. This is a strategic imperative equal to if not greater than the imperative that a firm must continuously innovate or perish.

All companies possess core competencies; whether originating organically from the core ideas, knowledge and skills of company founders who usher in a new technology and a set of capabilities into the market—to the largest firms, who do the same or who obtain skills, knowledge and intellectual property, and do so inorganically through mergers and acquisitions. No matter where a firm and its innovators may fall within this spectrum, it is now well recognized that a single business entity in isolation can rarely keep up with the continuous demand to drive innovation. With continuous global competition and an insatiable appetite from the market for innovations, companies need to improve and accelerate their innovation cycle. Open innovation has emerged as a means for all firms, large and small, to harvest more ideas from outside of the organization. With such an approach, firms augment existing innovation practices and share the risk associated with attempting to solve incredibly complex business problems. From our narrative and the three cases shared, it is our desire to impart to the reader that a co-innovation approach can indeed become invaluable to a firm and fully complement a firm's overall innovation strategy.

When additionally fused to the application of Design Thinking principles, innovation teams tap more deeply into customer perception and experience. The injection of Design Thinking into co-innovation project work ensures that project teams discover different ways in which to grow empathy. They learn to ask and listen, they watch and observe more deeply, and the actions of iterating, trying and doing become foundational to the work at hand.

Co-innovation enabled through a rich set of services has been key to the success of many SAP co-innovation projects well beyond the aforementioned three case studies. The prevailing truth discovered by all participants is that the sum of shared technologies and solutions delivers far more value than a single firm might capture on its own, while simultaneously lowering the risk and more rapidly offering greater rewards to the end customer.

Key Learnings

- To achieve the digital transformation one must change the attitude from closed innovation to co-innovation, which means to share ideas with external parties. This helps to jointly solve problems with complementary partners by sharing risks and costs that one alone could not achieve. Involving real customers into the co-innovation project makes the result even more valued.
- Understand new technologies by co-innovating with other parties gives the participating parties a better understanding of the pros and cons of such new technologies. Having at least a proof-of-concept provides certainty about the capabilities of that new technology that can be realistically demonstrated or simulated to then discuss with and convince customers for the need of a particular technology.
- A standardized approach with the adoption of the described services helps the participants to focus on what is core to the pure innovation realized by new technologies, and their resulting business values. Design Thinking helps with motivation in building an interdisciplinary team and to design a needed and valid use case for the end-user or customer.

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Cosmin Condea is a Strategy Consultant at SAP's Center for Digital Leadership. In his role, Cosmin translates market-shaping business trends into blueprints for next-generation digital enterprises, leads strategic discussions with key industry influencers, and consults top companies on how transform with digital technology. He has more than 9 year experience at SAP with a constant focus on identifying, pursuing, and monetizing innovation empowered by the latest information technology. A seasoned professional, Cosmin worked in key Research and Development and Business Development roles along his career. Cosmin holds a Ph.D. in Technology Management from the University of St. Gallen and INSEAD.

David Cruickshank is responsible for multiple operational facets of the lab including technical project development, project management and marketing. Prior to SAP, David was with Sun Microsystems serving as Solution Design Manager in Sun IT leading a team to deliver solution design and back line support required for client services development across a portfolio of software and services. Before joining Sun IT, David spent 4 years in Sun Services as program manager for Sun's global High Availability SLA program and lead Sun Managed Security Services to market with Verisign. David is a 20 year denizen of Silicon Valley high tech career has spanned various technology fields with both fortune 400 firms as well as start-ups spanning the network computing industry. David has a B.S. from Western Michigan University and an M.S. in Information Systems from Santa Clara University Leavey School of Business.

Pascal Hagedorn is responsible for the business development and project management as well as to showcase results from co-innovation projects at the Future Retail Center to customers, prospects and partners to discuss future topics with them. Pascal holds a Degree from the Technical University of Kaiserslautern in Business Administration and Engineering, majoring in computer science. Pascal found his passion in bridging the business and IT worlds to seamlessly operationalize what IT can solve with the business in the driver seat. Since then Pascal is working for SAP and proliferating his technical and entrepreneurial skills.

Virtual Reality Goes Mobile in the Digital Age

Erik Poppe, Désirée Gilgen, and Niz Safrudin

Abstract Virtual Reality (VR) goes back 50 years and was put to practical use in the 1980s when it was used by NASA to train astronauts. VR offers exactly that—the ability to experience the unfathomable. Today, VR is reaching the consumer by leveraging existing mobile phones as a platform for VR experiences. Innovative companies all over the world and across various industries are taking advantage of this technology, not only to convey the message of their business in a novel and immersive manner, but also to get closer to their customers by tapping into their emotional connection, which fosters customer engagement. In this chapter we show how three enterprises have embarked on mobile VR experience for their customers. We present the key challenges and opportunities, as well as business value and lessons learned from those digital initiatives.

1 Motivation

> *When I first got into it, nobody knew what it was that we were doing.*
> *It was like the Wild West.*
> —Margaret Hamilton[1]

The digital economy—also typically associated with the networked or hyper connected economy[2]—is presenting both challenges and opportunities for businesses. On one hand, the ubiquitous use of mobile devices facilitates real-time engagement between and among consumers and businesses. This in turn allows for the provision of a company's core offering and ultimately the generation of revenue and transactions after the normal working hours or geo-spatial location, to name but

[1]Margaret Hamilton's quote as a computer scientist at MIT who lead and directed the development of on-board software for NASA's Project Apollo.

[2]See Article 1 on Technology Trends and Implications for the Digital Enterprise.

E. Poppe
Queensland University of Technology, Brisbane, QLD, Australia
e-mail: erik.poppe@qut.edu.au

D. Gilgen (✉) • N. Safrudin
SAP (Switzerland) AG, Regensdorf, Switzerland
e-mail: desiree.gilgen@sap.com; norizan.safrudin@sap.com

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a few examples. Yet at the same time, the absence of boundaries in conducting business is also presenting a challenge for brick-and-mortar enterprises to provide not only a seamless customer experience, but also to delight them in order to maintain customer loyalty and foster repeated transactions across both digital and physical worlds.

Since recently we have been witnessing more and more companies that are turning to digital technologies in order to innovate and adapt to the digital transformation in their ecosystem. One of the digital technologies being used in these is Virtual Reality (VR) via mobile devices, dubbed mobile VR, which is lately gaining the attention of companies across all industries wanting to provide a unique digital experience for end-consumers. This phenomenon subsequently motivated us to examine two key questions:

1. What are the business benefits of mobile VR initiatives?
2. What challenges do enterprises need to manage in mobile VR initiatives?

The objective of this chapter is to shed light on how digital enterprises have managed to innovate with mobile VR. In addressing these questions, we will first present the background to clarify and define what 'mobile' means in the digital economy. We define VR including a rundown of its history, offering our understanding of mobile VR. We then provide some actual cases for the use of mobile VR, followed by our findings from three case studies, highlighting the challenges and opportunities, and its resulting implications for businesses. We finally conclude with key lessons learned and an outlook on the changes that mobile VR technology could enable in the future.

2 Background

In this section we seek to define what mobile VR is, what it can do that other digital technologies cannot, and where has it been applied so far. But first, let's take a look at the definition of mobile in the digital age.

2.1 Definition of Mobile Technology

'Mobile' is commonly (mis-)understood to refer only to mobile phones or smartphones. This term, however, especially in the digital economy, goes beyond this conventional understanding, since contemporary technologies such as tablet PCs and wearables can also be classified as 'mobile' technologies. The Oxford Dictionary (Stevenson 2015) definition of 'mobile' however is much broader:

1. Able to move or be moved freely or easily;
2. Of or relating to mobile phones, handheld computers, and similar technology;

3. Able or willing to move easily or freely between occupations, places of residence, or social classes.

The three possible uses listed above fully capture the essence of what mobile means in the digital economy, and are therefore included in the following summary:

> Mobile is the ability to move around freely with and through mobility-enabling technologies, such as handheld computers (e.g. mobile phones), which allow us to be a part of—and to participate—in a global and hyper-connected world.

Having clarified the definition of mobile, we will next turn to examining the concept of VR.

2.2 Background on Virtual Reality

Most consumers may perceive VR as something new. Few know that VR's roots go back as far as into the 1960s. The following lists some of the many milestones in the history of VR:

- In 1960, Morton Heilig created a multi-sensor simulator called Sensorama. The Sensorama was the first machine enabling you to experience videos augmented by binaural sound, scent, wind, and vibration (4-Dimensional or 4D experience).
- A few years later, Ivan Sutherland proposed a concept for an artificial world constructed by interactive graphics and created the first VR system in hardware: a Head-Mounted Display (HMD), with appropriate head tracking.
- In 1982, the US Air Force's Armstrong Medical Research Laboratories developed an advanced flight simulator, the Visually Coupled Airborne Systems Simulator.
- In 1984, the NASA Ames constructed, using off-the-shelf technology, a stereoscopic monochrome head-mounted device: the Virtual Visual Environment Display.

  The first commercially available devices were the DataGlove (1985) and the Eyephone HMD (1988), produced by the VPL Company (Mazuryk and Gervautz 1996).

Today's state-of-the-art commercial VR include the Oculus Rift HMD, the Samsung Gear VR produced by Oculus in collaboration with Samsung, the HTC Vive and the Sony Playstation VR headset. The Samsung Gear VR HMD is a set of goggles with two lenses, and a motion sensor. It connects to a Samsung phone. Samsung made this VR hardware with insights gained from Oculus' own R&D. In return, Samsung created custom displays for the Oculus Rift, which will be commercially available in mid-2016 (Rubin 2015).

While science-fiction and popular culture have established a public image of VR as computer systems with head-mounted displays, the term generally describes a broad class of systems that combine various hardware and software technologies to achieve a fully immersive experience. Traditionally, VR has therefore been defined from one of two perspectives (Steuer 1995): (1) the technology and (2) the experience.

VR is often defined in reference to a particular technological system. Usually this system includes a computer capable of real-time animation, a head-mounted stereoscopic display for visual output, and maybe a set of wired gloves and a position tracker for user control.

VR is defined in many ways. On the one hand, VR can be defined as referring to the electronic simulations of environments experienced via head-mounted eye goggles and wired clothing enabling the end user to interact in realistic three-dimensional situations (Coates 1992). These three-dimensional or 3D situations offer an alternate world filled with Computer-Generated Images (CGI) that respond to human movements (Greenbaum 1992). Steuer (1995), however, points out that such definitions are too limited, as they do not acknowledge differences in experience between different VR systems. In Steuer's understanding, VR is about the human experience of one's physical environment, i.e., of a sense of presence. Steuer (1995) states that the term presence in this sense refers not to being in a physical location but to the perception or feeling of being present in an environment. Gigante (1993) accordingly defines VR as an immersive, multisensory experience, creating the illusion of participating in a synthetic environment rather than being an external observer of such an environment. However, Steuer also points out that presence can be achieved in various degrees via the use of any media and does therefore not uniquely distinguish VR.

Consequently, we need to somehow define VR in a manner that distinguishes it from other experiences. Biocca and Levy (1995) suggest we see VR as systems that connect the user's senses in a unique way to a computer simulated virtual environment. Building on this idea, Milgram and Kishino (1994) describe a taxonomy of systems distinguished by how they interact with the user's perception in their *Reality-Virtuality continuum* (see Fig. 1) with real environments shown on one end of the continuum, and virtual environments, at the opposite end of the spectrum. According to this classification, a system: may not change any sensory cues the user perceives (reality), can add some simulated cues to existing real cues (Augmented Reality), can add some real cues to simulated cues (augmented virtuality), or replace all real cues with simulated cues (virtual reality).

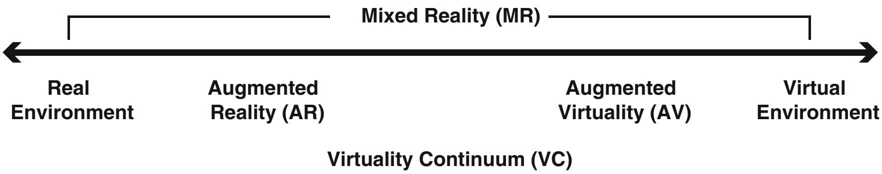

Fig. 1 Virtuality continuum—distinguishing real from virtual environment (adapted from Milgram and Kishino 1994)

These different realities provide different benefits for different purposes. While VR immerses the user completely in a computer generated environment or in a captured real environment (via video or photo), Augmented Reality (AR) enables users to add information to their physical environment. For example, an AR app can superimpose a piece of furniture in your living room or overlay animated maintenance instructions on a water pipe while the consumer is on site (McKalin 2014). SAP® Augmented Reality Mobile Application can empower employees to work hands-free using gestures and voice recognition to access information such as remote expert calling, visualization, and 3D animation. For example SAP Work Manager's Augmented Reality App shows the service technician or warehouse picker the right way to the right object location in real-time. In addition the service technician can get 3D instructions on-site on how to repair the object and, if needed, call a friend and let this friend follow his activities through use of a camera. The inventory picker can scan the products to be chosen right away through the AR device. The app helps service technicians improve service quality and efficiency, and also helps warehouse pickers to increase their speed and responsiveness in outbound picking processes, by embedding additional information into their physical work environment.

VR, on the other hand, can replace the user's real environment, by transporting them, for example, to remote or even imaginary locations, such as a warehouse at the other end of the world or to a building devised by an architect, but one that has not yet been built. Such instances allow users to be completely immersed in the virtual world without being distracted by the real one, which, for example, benefits collaboration and training purposes.

While currently systems can clearly be separated into AR and VR, leading industry experts, such as Oculus Rift founder Palmer Luckey, expect VR and AR to merge into one hardware device in the future, one that can be moved freely and may eventually supplant smartphones (Price 2015).

Having understood the fundamentals of both mobile and VR, we accordingly define a mobile VR system, as follows:

> A mobile VR system creates the illusion of participation in a simulated environment, rather than external observation of such an environment, by replacing real sensory signals that the user perceives with simulated sensory signals through the use of portable technology.

Having clarified the concepts of VR, including mobile VR, we next highlight some applications or use cases across various industries.

2.3 A Glimpse at Cross-Industry Applications

To date, many organizations have embarked on initiatives in developing mobile VR across different industries and business departments. In the health industry, for example, Professor Albert Rizzo, Director of Medical Virtual Reality University of

Southern California, is involved with several topics of research into VR. At the Dutch VR Days,[3] the first European Conference on VR, held in Amsterdam, Professor Rizzo talked about use cases of VR to treat addiction, ADHD, Alzheimer's, balance disorders, cerebral palsy, neglect, pain distraction, phantom limb, Posttraumatic Stress Disorder, stroke, Traumatic Brain Injury, Parkinson, spinal cord injury, and much more.

Samir Boulema, Lead Software Developer of Funda, showed how VR can be used in real estate to reduce the number of visits to potential properties, thereby saving time for real estate agents and their clients.

Another thought-provoking use of VR is in education, where VR can support training in sports, medical expertise, public services, a technician's work, and much more. An additional scenario for VR is allowing privileged access to events such as providing front-row seats in a fashion show, a sports event, or a concert.

Last but not the least, marketing and customer experiences can be made to be more engaging through VR allowing consumers to not only watch but also participate in the event. An exciting VR experience involving a product may influence the consumer to buy the product (Messinger et al. 2009). Automotive companies such as BMW,[4] Mini,[5] Audi,[6] and Lamborghini[7] have created various mobile VR experiences to not only introduce their consumers to new cars and concept models, but also to engage consumers in a cinematic experience. BMW for instance, created the world's first virtual motorbike ride enabling the general public to experience what it is like to ride a motorbike on a racetrack using a Samsung Gear VR or HMD while sitting on a stationary BMW motorcycle. In order to further enhance the mobile VR experience, a fan for wind effects and a vibration backpack provided a simulated but realistic motor bike race experience. Swedish car manufacturer, Volvo, highlighted the significance of designing user experience not just in the virtual environment, but also in the real one.[8] This approach is attributed to the utilization of mobile VR content, where, as part of its marketing campaign, Volvo allocated a dedicated physical space (real environment) for users to enjoy the Volvo's VR experience without interruption, and get to know the brand from a different angle.

Table 1 summarizes the list of use cases in various industries that we have derived as part of our investigation.

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[3]See http://dutchvrdays.nl

[4]See BMW Eye Ride experience https://www.youtube.com/watch?v=34JDQGtalZY

[5]See Mini 'Backwater' cinematic VR experience https://www.youtube.com/watch?v=nz_W1Vb7IQ4

[6]See Audi virtual test drive https://www.youtube.com/watch?v=PFd3fvjypfc

[7]See Lamborghini showcase at Geneva International Motor Show 2015. https://www.youtube.com/watch?v=6Gn5BElEhFU

[8]From Dutch VR Days conference.

Table 1 Overview of VR use cases across various industries

Industry applications	Use cases	Benefits
Arts, entertainment and recreation	• Participating in interactive theatre performances, concerts, and other events • Gaming that introduces VR world with existing game consoles, e.g., Sony PlayStation VR • Sound displays and installations, where users interact with musical instruments or in VR environment • Visual art displays and installations, where artists have a new medium to showcase their talent • Attending museums, exhibitions, different cultural/historical settings, and heritage sites • Taking a virtual walk in a foreign city, country, or continent	• New products/services • New source of revenue • New marketing and communication channel • Deepen customer relationships
Construction	• Simulating a walk-through buildings that have not been built yet in a safe, virtual environment • Simulating interior and exterior design of buildings, moving objects around in a room before implementation • Visualizing and immersing users in construction sites	• Alternative medium for visual design • Alternative means for training and education
Wholesale and retail trade	• Experiencing a view of a new vehicle model from a driver's perspective • Immersive user experience of being physically in the driver's cockpit, e.g., test-driving a new concept or model of a car at an Autobahn • Virtual fashion shows and stores • Trying on clothes in VR environment	• New marketing and communication channel • New products/services • Alternative medium for visual design • New source of revenue • Deepen customer relationships
Education	• Presenting complex data in an accessible way—e.g., astronomy classes where students can touch and track planets, stars, and comets using VR gear such as gloves • Providing product, method, and technic trainings, e.g., in medicine and surgery	• New communication channel • Alternative means for training and education
Financial and insurance activities	• Improve customer experience by transforming blocks of data into a more immersive trading environment, with the portfolio representing a city and each position representing a building • Remote visualization of complex investment portfolios for young clients (millennial) as an alternative to visiting in-store • Wealth management tool with interactive retirement planning application that helps users visualize themselves (via CGI) and their journey toward retirement	• New means of data analysis and visualization • New communication channel • Deepen customer relationships

(continued)

Table 1 (continued)

Industry applications	Use cases	Benefits
	• Use of VR headsets in developing markets to experience the same customer engagement activities in emerging markets when carrying out traditional banking activities	
Human health and social work activities	• Surgery simulation as a part of the training aid • Human simulation—conducting surgery in an interactive environment in compliance with the chosen training scenario • Robotic and telesurgery—performing an operation while the doctor and a patient are in different locations • Wide range of treatments (e.g., phobias and post-traumatic stress disorders) • Conducting experiments and measurements movement of patients with Attention Deficit Disorders (ADD) in a simulated environment	• Alternative means for training and education • Research and development • New ways of working remotely
Manufacturing	• 3D modelling and visualization throughout full design cycle • Prototyping and testing airplanes, cars, and other complex products	• Alternative means of data analysis and visualization • Alternative medium for visual design
Mining and quarrying	• Simulating mining environments for training	• Alternative means for training and education
Oil and Gas	• Used in oil-field training for new employees • Visualization and simulation of data to assist in decision-making process • New and potential employees are able to grasp the environmental context in which oil and gas companies operate in, thereby bearing the potential to keep high-risk mistakes to a minimal	• Alternative means for training and education • Research and Development • New marketing and communication channel
Professional, scientific and technical activities	• Architectural and engineering viewing a blueprint with a 360° view, providing full user experience • Simulating and manipulating data in virtual environment for data analysis purposes • Advertisements created by marketing agencies for new products and services • 360° photography for commercial and consumer photograph production (e.g., aerial photography, tourism, etc.)	• Alternative means of data analysis and visualization • Research and development • New marketing and communication channel
Public administration and defence	• City and urban planning by discussing designs for professionals and civilians to minimize misunderstandings and get feedback from civilians • Combat visualization, flight/parachuting/	• New marketing and communication medium • Alternative means for education and training

(continued)

Table 1 (continued)

Industry applications	Use cases	Benefits
	battlefield simulation • Weapon simulation	
Real-estate	• Providing virtual or remote visits to properties via videos or 360° photos through mobile VR	• New marketing and communication channel • Deepen customer relationships
Information and communication	• Publicizing sport events where users can 'try out' new sport experiences, e.g., windsurfing, bungee jumping, and mountain skiing • An alternative medium of bringing new ways of telling stories: VR and cinematic VR calls for the creation a new visual interaction and language	• New marketing and communication channel

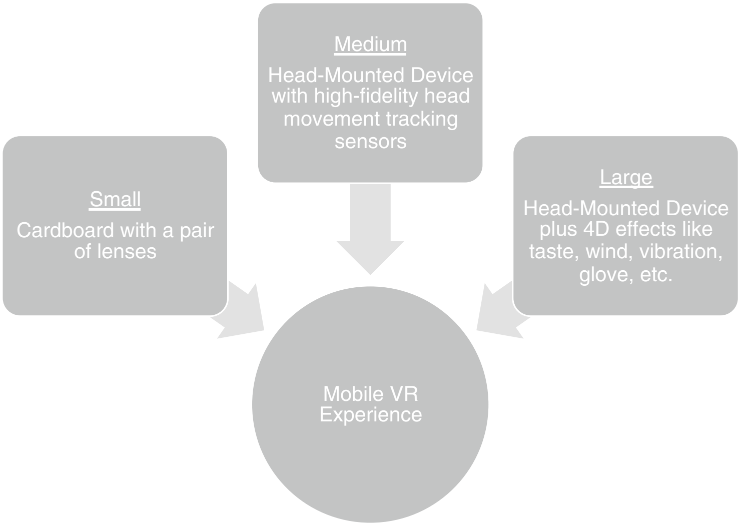

Fig. 2 Three types of 'sizes' for mobile VR experience

2.4 *Three Sizes for Mobile VR Experiences*

Mobile VR experiences can be classified into three sizes: small, medium, and large (see Fig. 2, building on Peder Sandqvist's model who was speaker at the Dutch VR days) model that describes Oculus' Development Kits 1 and 2, which also includes 4D effects. We extend this model to mobile VR based on portability, and the insight that was derived through researching different use cases (see Fig. 2). In our model we shall talk about head mounted devices in general.

A *small* mobile VR experience is provided by a smart phone viewed through a pair of lenses in a VR cardboard. A VR cardboard is a carton that contains a pair of convex lenses and a section allowing you to insert a smart phone in front of the lenses. The experience can use the sensors of the smartphone for head tracking, however the tracking abilities are less accurate than those of the dedicated sensors of a Gear VR. A strap may be added optionally so that the VR cardboard can be worn as an HMD. The advantage of the small experience lies in the equipment being readily accessible—the VR cardboard is inexpensive and most people own a smart phone. Therefore, the experience is scalable. Many people can be reached easily by very conventional means such as by sending them a folded cardboard 'do it yourself' by mail, allowing users to then download the relevant mobile app.

A *medium* mobile VR experience is provided with a dedicated HMD, such as Samsung Gear VR, in which high-fidelity motion sensors track the user's head movements. The sensors embedded in the HMD enable better accuracy in tracking the movements of the user, which improves the experience of viewing the content displayed in the mobile device.

A large mobile VR experience uses an HMD in combination with 4D effects to let users experience what it is like to use a product. The BMW motor bike use case is an example.

Based on our observation of several use cases at the Dutch VR Days in Amsterdam we find that these different sizes of mobile VR experiences are the key for the scalability. This is because the created content can not only be enjoyed in dedicated showcase areas but also at home by using a cardboard or a Gear VR together with a downloaded mobile VR App, plus complementary effects to enhance the user's experience.

2.5 Summary of Background

To summarize the background of mobile VR as an emerging technology it is important to point out that this technology is not new but has been evolving since the 1950s. However, only since recently have businesses really started to create mass-market applicable use cases and not ones restricted to only a few institutions like the Air Force and NASA. For a long time the VR hardware consisted of big and heavy machines which were neither mobile nor scalable. Mobile screen resolutions and graphic hardware performance have made significant improvement over the past 60 years. Another reason for businesses to start looking into VR are large investments made by companies like Oculus, Samsung, Google, Microsoft, and Apple into VR. Moreover, they have already made the technology accessible on three sizes, which can contribute to the scalability of mobile the VR experience. Because of this it has become relevant for enterprises to find out in what ways and if at all mobile VR can disrupt certain processes or even the business model.

3 Case Studies

For this chapter, we have investigated three case studies on businesses using mobile VR. For each case, we wanted to gain an understanding on how digital enterprises manage their mobile VR initiative. In particular, we asked the three organizations about: (1) the background of the project including motivation, parties involved, and approach taken, (2) the business challenges that the initiative sought to address, including value of initiative and lessons learned, and (3) a future outlook of mobile VR from the participants' perspective.

In seeking some answers to our questions, we conducted three case studies through our industry partners and/or customers, where we conducted interviews via a structured questionnaire, and also through 1 h verbal semi-structured interviews.

3.1 Case #1: eMotion of Samsung Electronics Italia

About Samsung Electronics Italia SPA The Samsung Group is a world-class corporation with businesses ranging from advanced technology and semiconductors, to skyscraper and plant construction, petrochemicals, fashion, medicine, finance, hotels, and more. The company was founded 1969 and quickly became one of the major manufacturers in Korea. Today Samsung has about 489,000 employees and a net income of approximately 16 billion Euros. Samsung Electronics Italia is one of its subsidiaries. It specializes in the electronics business of the Samsung group, and is based in Milan, Italy.

Parties Involved eMotion is a collaboration between Samsung Italia and the Santa Maria Goretti Hospital in Latina, a city near Rome. Together they have developed a remarkable VR use case[9] that has the aim of cheering up hospitalized children and to assist their return to good health.

Forget Fragile Health Conditions for a Moment The eMotion project was designed to use Samsung's Gear VR to take the kids on a virtual trip to Movieland amusement park. The Gear VR provides a 360° camera view of a variety of rides and attractions. The virtual adventure would allow these children to forget about being in hospital for a few moments, to enjoy an adventure, and to maintain a positive attitude during their stay in hospital (Samsung Newsroom 2015).

Implementation Process The product was very new at the time. 360° videos were not easy to develop both in terms of shooting hardware (360° cameras) as in those of post-production. Consequently a full new production using fairly new techniques

[9]View the YouTube videoclip by Samsung Italia on https://www.youtube.com/watch?v=qDlreTwJsfs

implemented in order to deliver the best possible product. Through rapid prototyping and trying out different scenarios, namely in terms of applications and solutions, the team then decided on what would be the best strategy to apply. This efficient and effective approach assured a lean project. Samsung was able to achieve a result that had a great impact on the target group and generated a very positive Word of Mouth.

Implementation Challenge One challenge of the project lay in finding a mode of entertainment suited for the target audience—kids who are hospitalized for an extended period. The goal was to find the best possible entertainment experience in order to help them enjoy a few moments in a world outside the hospital—and have fun.

Benefits of Mobile VR Samsung's mobile VR eMotion project, an example of a medium-sized mobile VR, had two benefits: for Samsung, the value of this project lay in a halo effect onto a brand putting its technology and engineering at the disposal of a community. For the hospitalised children, the use of mobile VR gave them a unique chance to forget about their illness for a moment, while escaping their real world environment, all of this being attributable to the unique features of mobile VR.

3.2 Case #2: Biotechnology, Biogen

About Biogen Biogen is one of the oldest independent biotechnology companies in the world. Its mission is to develop, market, and manufacture therapies for people living with serious neurological, autoimmune and rare diseases. The company was founded in 1978 in Geneva, Switzerland, and is headquartered in Cambridge, Massachusetts. It employs more than 7000 people worldwide, with offices across the globe.

Experiencing Business Complexities Biogen embarked on a mobile VR project as part of its attempt to showcase the process excellence and manufacturing expertise at its European-based manufacturing facility. The intent was to invite all customers to visit their state-of-the-art facility and to see how Biogen manufactures its advanced biologic therapies—and in particular, biosimilars. A VR visit to the facility offers the possibility of giving customers a greater appreciation for the complexity of the technologies and processes involved, letting them see first-hand the considerable expertise needed to precisely manufacture advanced biologics—at scale.

Uninterrupted and Immersive Experience Biogen and the technicians involved understood that, unlike traditional film, an immersive VR experience would give customers a sense of scale and place. For example, a visit inside a two-storey bioreactor is something a film could never convey. The team felt that VR thus provided a more memorable way of bringing the story to life. Plus, the VR 360° view provided an uninterrupted and engaging experience.

Parties Involved Several groups were involved in producing the VR experience. The GSW inVentiv Health team played an instrumental role in concept development, R&D, show production, and hardware exploration. VR content producer, The Mill, were recruited for 360° filming, video editing, and production. Biogen's biosimilars marketing team added their marketing expertise and developed a VR film script that allowed customers to experience why manufacturing matters for advanced biologics. Biogen employees at the manufacturing site and elsewhere all contributed to the project and some even featured in the final VR video.

Implementation Process Biogen has joint venture with a division of Samsung, called Samsung Bioepis, in the emerging area of biosimilars. The partnership allowed for a unique opportunity to bring together consumer technology for a targeted healthcare provider audience. The Biogen team selected Samsung hardware, i.e., Samsung Gear VR and Samsung S6 Edge mobile phone, along with noise-cancelling Bose headphones to use. After this was done, the GSW team began testing the video iteratively and tested how best to start the video where it could be handed to a viewer that had not ever used the hardware. This was important as the team planned to use it at key medical congresses and in one-to-one customer meetings. With some basic rehearsals, the lessons learned were then passed on to the customer facing team.

One of our key observations is how Biogen emphasized concern with a factor typically overlooked: hygiene. The company was particularly aware of this, especially where ever there was equipment shared among many users. Biogen demonstrated an appreciation for user comfort, not only by having high quality content and using a high quality audio output, but also by having consumers experience the content in a safe and comfortable space (e.g., designated room) with sanitized equipment (e.g., wiping the Gear VR with a cleaning cloth before use). Such instances show how attention to detail can influence the overall experience, requiring consideration for both the physical and the digital world for a seamless consumer experience.

Implementation Challenge At the time, VR technologies were new to the GSW and Biogen teams. Nevertheless, the team adopted a 'learn as you go' approach. Whenever possible, they built in longer review periods to ensure alignment of the overall initiative. The implementation team also conducted live reviews to give stakeholders the opportunity to ask questions and get real-time answers. By learning about VR technology and applying it, the team grew more comfortable with the technology and its capabilities.

Value and Benefits of Mobile VR The benefits of Biogen's medium-sized mobile VR initiative are twofold:

1. Both external customers and internal consumers were able to experience Biogen's manufacturing facility from wherever they were, immersing themselves in the mobile VR environment unique to a conventional VR platform.

Its CGI allowed customers to appreciate the scales involved—from 15,000 litre bioreactors, to comparing the size and complexity of a monoclonal antibody to a simple, small molecule drug. The experience allowed customers to see the high level of experience of Biogen's capabilities, its staff, its process excellence, and the standards Biogen imposes in developing biologic therapies, especially biosimilars.

2. The 2-to-3-min experience recorded in mobile VR mode served as a crucial asset that has since seen amortization in several areas. It is currently being used both as a communication tool at global and local events (such as congresses or conferences) and as a sales aid for customer-facing employees. An unforeseen communications opportunity has also been leveraging the technology with employees across the company to help them better understand the manufacturing processes.

Next, we describe the case of a joint mobile VR initiative between a respected fashion company, Tommy Hilfiger, and a start-up enterprise in The Netherlands, WeMakeVR.

3.3 Case #3: Retail, Tommy Hilfiger by WeMakeVR

About Tommy Hilfiger Tommy Hilfiger is one of the world's leading designer lifestyle brands. The company, founded in 1985, was acquired by PVH Corp. in 2010, and today has more than 17,000 associates worldwide. Tommy Hilfiger is present in over 115 countries and more than 1500 retail stores throughout North America, Europe, Latin America, and the Asia Pacific regions. Global retail sales equivalent for the Tommy Hilfiger brand was US$6.7 billion in 2014.

Parties Involved Tommy Hilfiger, together with WeMakeVR, a VR content provider from Amsterdam, created a unique fashion experience. WeMakeVR is a pioneer in the world of VR and has been creating VR experiences since 2013. It created a revolutionary camera system to produce true immersive 3D films for VR and produced one of the world's first fully stereoscopic-3D VR music videos.

Make an Exclusive Event Accessible WeMakeVR founder, Avinash Changa, said in our interview, "What if we could give consumers all over the world the opportunity to be a front-row VIP at one of the world's most exclusive fashion shows?" With this concept, WeMakeVR approached the global CEO of Tommy Hilfiger, Daniel Grieder. With an eye for innovative technologies, Grieder immediately saw the potential of such a 'Fashion Show of the Future' concept. The VR worked so well that Tommy Hilfiger decided to roll it out in select flagship stores globally to let consumers all over the world watch the fall 2015 'Hilfiger Collection' runway show from an HMD in Tommy Hilfiger stores. While seated in front-row seats in this 360° 3D VR, customers could at the same time purchase items from the collection. Tommy Hilfiger described the VR offering in the following way:

"From the incredible set and music to exclusive backstage moments, consumers will be able to watch the clothes move and see the collection in the original show environment—it's a compelling and interesting elevation of the traditional shopping experience." This VR experience was offered in several of the Hilfiger stores, such as the one on Fifth Avenue in New York, the ones in London, Paris, Milan, Amsterdam, Dusseldorf, Sao Paolo, Florence, Zurich, Moscow, as well as select wholesale partners, such as Selfridges in London and SMETS in Belgium (Arthur 2015).

Implementation Process Along a timeline consisting of a couple of months, WeMakeVR produced the content in various steps, these were: concept development, pre-production, location preparation, and the shoot of the actual show. The film was then put through two post-production phases. In the first phase, the content was offline-edited. In the second phase, the footage was rolled out through an application called WeShareVR (available in app stores). To film the show, WeMakeVR used its special VR 360° camera.

Implementation Challenge As VR is a relatively new technology, the production planning schedule needed to allow for extra time to explain the technology, how it works in detail, and what it's capable of delivering. People are just beginning to understand all the possible uses VR can be applied to, therefore an active, hands-on, 'learning by doing' approach is often required. Furthermore, given the size and scope of the 360° camera, VR camera crews work in a manner very different to that of regular camera crews, usually taking up more space and requiring different equipment.

Benefits of Mobile VR The Tommy Hilfiger virtual fashion show works on different levels. For the wholesale team, it provides buyers with a show experienced from the best seats of the event including back stage impressions. This allows buyers look at the styles in a different way and get more excited about the collection. For the retail side, it helps drive store traffic because consumers enjoy the chance of attending such an exclusive show and being able to even go backstage with the models. Added on to this, the initiative generated a lot of publicity. The New York Times, Forbes, and other print and online publications covered the project. The Tommy Hilfiger case represents a medium mobile VR experience delivering a virtual trip of an exclusive runway show to all customers by using an HMD with head tracking sensors.

3.4 Summary of Case Studies

In summary, the case similarities and the outcome results consist in an increase in perceptual value and emotional impact from what is perceived by the users to be a delightful consumer digital experience in the digital age. Case differences lay in motivational factors, ranging from an intent to communicate, to entertain, to

Table 2 Overview on case studies of businesses using mobile VR as part of our investigation

Case	Description	Purpose(s) of initiative	Outcome(s) of initiative
1	Samsung Italia's eMotion project for a children hospital	• To take hospitalized kids outside of a hospital environment • To demonstrate affordances of Samsung Electronics, i.e., Gear VR	• The community (kids, hospitals, doctors and parents) are delighted • Samsung seen as an innovative digital enterprise, offering novel technological solutions
2	Biogen IDEC's showcase of its manufacturing facility	• To take their customers and physicians to its state-of-the-art manufacturing plant • To educate and inform physicians about the excellence adopted in their business	• Customers and physicians gain an understanding of Biogen's business • Demand for content and Gear VR, viz. mobile VR, as a next generation of users experience in the digital age
3	Tommy Hilfiger's Fashion Runway & Backstage Access	• To democratize fashion runways to the general public	• Brought access to the fashion experience in Tommy Hilfiger stores (New York, Amsterdam, London, São Paulo, Zurich, etc.) • Gained reputation as an innovative digital enterprise by being an early adopter of mobile VR as a next generation of users' digital experience • Established a new communication medium and corporate asset

educate, to share and finally to immerse the audience through an emotional (digital) experience.

As can be seen from the overview of our case studies (Table 2), our observation suggests that the companies were able to use mobile VR to bridge the gap between the digital and the physical world. This in turn has the potential for providing a seamless customer experience across both worlds, subsequently contributing to the competitive advantage of businesses in the digital economy.

3.4.1 Summary of Business Challenges

In the Samsung use case, the challenge was to find the right content, a pleasant and joyful entertainment suitable for hospitalized children. The team chose a VR theme that could temporarily transform the kids' experience into one that was fun. Another challenge was that, 360° videos were not easy to develop, both in terms of film hardware (360° cameras) and post-production. Samsung and Tommy Hilfiger were able to achieve a result that had a great impact and generated a positive word-of-mouth.

Another challenge has to do with the hardware. Due to the recent advancement made in mobile VR, we often hear remarks about how the resolution of the display ought to be improved. In addition, prolonged use of mobile VR would require the user to take breaks from using the technology so as to avoid the mobile device overheating and in order to recharge it. Nevertheless, it is only a matter of time before both hardware and software technologies will overcome these challenges. Leveraging mobile accessibility for short use (e.g., 5 min instead of 30 min viewing) also allows for a succinct delivery of key messages to the end user.

The equipment required to produce VR content can be expensive, despite its advancement, particularly when CGI effects are added to the recorded 360° video content. Still, such investment has been worthwhile for Biogen. Many other departments have found use for the content and have ordered additional Gear VR and mobile devices for both internal and external showcasing of the business.

As experienced by WeMakeVR for Tommy Hilfiger's project, employees who are non-technical may find it difficult to use a HMD. Hands-on training and proper guidelines are required, as well as adopting 'learn as you go' attitude demonstrated by Biogen and Samsung. This implies building commitment within the organization to create a multiplier effect.

Due to these findings the main challenges are finding the right content, producing with new technologies like 360° cameras and working around the technology constraints of the Gear VR. Furthermore cost, hygienic use of HMD, safe and comfortable showcasing space are challenges which should be taken into consideration for future VR use cases.

3.4.2 Opportunities from Using Mobile VR

The initiative of Samsung Italia and the Santa Maria Goretti Hospital was to develop a remarkable VR use case aimed at cheering up hospitalized children and help them in their return to good health. However, the effects of executing the project went beyond that goal. The project boosted the perceptual value of the Samsung company as a whole and created a halo effect for their brand. Nonetheless, Biogen's motivation for its mobile VR initiative was creating an opportunity for its customers to visit its state-of-the-art manufacturing facility, and see how Biogen makes advanced biologic therapies. To see this gives customers a greater appreciation to the complexity of the technologies and processes involved.

In both cases, i.e., Biogen and Samsung, VR technology helps in showing a new way of consuming and experiencing content in the digital economy through a compelling story and the immersive, unique experience for the end user. Biogen in particular sees VR to be an ideal platform for the life sciences industry, provided costs for film production and players decrease. Businesses can leverage the platform by using it for training internal people as well as educating customers and allowing people to simultaneously engage in a VR environment.

Tommy Hilfiger's incentive was to give consumers all over the world the opportunity to be a front-row VIPs at one of the world's most exclusive fashion shows. From the incredible set and music to exclusive backstage moments, consumers are able to watch the clothes move and see the collection in the original show environment, which is a compelling and interesting elevation of the traditional shopping experience. In addition to this, this customer experience helped to get buyers more excited about the new collection allowing them to get a better look at the clothing styles. VR can provide users with experiencing places they had not been able to go to before; raising curiosity for and appreciation of being able to attend such an exclusive event. In other words, what a once restricted or limited access to a physical part of the real world is now being made accessible for everyone through the use of mobile VR.

We notice throughout our observation that, while the majority of users are amazed with mobile VR, there are still many users—and businesses—who are apprehensive about what the digital technology has to offer. Businesses can learn by experimenting with VR technology in an agile manner, while re-imagining how to perform current work differently, or how to perform different work altogether. Enterprises who are already experimenting with mobile VR expect this to be a new medium for engaging their consumers.

4 Implications and Future Outlook

In this section, we synthesize our findings from literature and case studies. Furthermore, our analysis and interpretations throughout the duration of the study were enriched by our on-site observations and experience at the Dutch VR Days Conference[10] in Amsterdam, the Netherlands.

4.1 Mobile VR as a New Channel for Consumer Digital Experience

We asked the teams involved in the use cases for their thoughts on the outlook of VR in the next 5 years. The majority predicted that VR technology would be a new way of consuming and experiencing content in the digital economy, for both consumer and B2B orientation. This is largely due to the immersive and unique experience for the end user, which can assist in delivering a compelling story. Biogen in particular sees VR to be an ideal platform for the life sciences industry, provided the film production and player costs decrease. Businesses can leverage the platform by using it for training internal people as well as educating customers. Furthermore, Biogen envisions endless possibilities for VR because it allows many people to engage in a VR environment at the same time.

[10]See http://dutchvrdays.nl

We believe that it is important, in order to provide this engaging experience, to carefully curate VR content, e.g., to avoid mismatches between vestibular senses or proprioception (sense of balance and spatial orientation) and the visual senses. The combination of multiple digital technologies such as VR, AR and mobile devices will re-define the way consumers learn, work, and play (Parkin 2015). In the following we highlight two ways in which mobile VR can achieve this kind of impact.

4.2 New Ways to Increase Perceptual Value and Branding

One of the prominent effects of Samsung's eMotion initiative was the halo effect on the brand that the community assigned to it. While the initiative was to help kids in hospital maintain a positive attitude, the effects of executing the project went beyond that goal. The project boosted perceptual value of Samsung as a whole. 87 % of global consumers believe that businesses should place at least equal emphasis on social interests as on business interests; the project had that effect for Samsung. This perception of corporate 'purpose' has increased as a purchase trigger by 26 % since 2008 (Edelman 2013). For digital enterprises, this implies configuring their digital business models to deliver products and/or services to customers that go beyond mere operational efficiency and effectiveness. One of the ways of achieving such competitive advantage, particularly in the digital ecosystem, is to address the emotional needs of consumers, because: (a) 80 % of an individual's life is shaped by emotion, while only 20 % is governed by intellect (Lough 2006), and (b) establishing an emotional connection between a product and the consumer determines the success or failure of such an offering, because it is a distinct way of forming a one-on-one relationship between the product and consumer (Overbeeke et al. 2002). Mobile VR enables businesses to strengthen 'Customer Centricity' and branding through emotional engagement.

4.3 Gaining Access to a Different Perspective

Different perspectives generate curiosity among users, in which they can gain new insights and stimulate creative impulses. For example, the Tommy Hilfiger use case allowed the wholesale buyer to get a better look at the clothing styles, and helped to get buyers more excited about the new collection. VR can also provide users with places they had not been able to go to before, such as the front row of a runway show. This in turn raised curiosity and increased store traffic, because consumers wanted the chance to attend such an exclusive show. In other words, what used to be a restricted or limited access to a physical part of the real world is now accessible anytime and anywhere with mobile VR.

4.4 Future Outlook

In the case studies the participants were asked where they see mobile VR in 5 or 10 years. In 5 years, they stated, VR technology will have a wider adoption as a new medium for experiencing content, either on location or at home, for both B2B and retail markets. This seems likely, because retailers are already working on virtual shopping experiences so that in 5 years retailers will no longer be limited by physical store space. They will be able to redesign stores for each new collection or even for each consumer's preferences. Social mobile VR can create interesting shopping experiences to be shared with a friend or partner who will then be able to shop with you, even if the other person is on the other side of the world.

It is hard to predict where this technology will be in 10 years. However, technology will be more and more embedded into our real life, bringing benefits to end users. Digital technology is one of the fastest evolving industries in the history of technology. But when we look 3–5 years into the future, we can well imagine mobile VR applications in sports, music, and entertainment. There will be virtual artists and completely new storytelling formats that go far beyond what we currently experience with television, cinema, and gaming.

For commercial applications, VR will see more common use in real estate, design, sales, etc. However, the biggest impact will be in the social area of mobile VR, such as in healthcare applications, elderly care, newsgathering, treatment of phobias, and education. These worlds will be transformed through mobile VR.

Mobile VR presents an immersive and engaging medium, and is suitable for telling stories. Imagine, instead of listening to a teacher explaining what life is like in Japan, or Africa, you could actually be there through an app on your personal smart phone. Mobile VR experiences can be shared with hundreds of millions of people. And by creating powerful, meaningful applications, businesses are well underway to changing the way we experience reality.

5 Conclusion and Key Learnings

In conclusion: mobile VR as a contemporary technology can bring various benefits to businesses. These include: new means of engaging customers, new ways of working, an increase in the perceptual value of the business. On the other hand mobile VR also causes challenges when implementing such as the use of 360° cameras and curating VR content, choosing the right content, ensuring a comfortable experience, hygiene and ramping up organizational capabilities. In the future we can imagine mobile VR to be ubiquitous in both personal and professional lives.

Key Learnings

- The combination of digital technologies such as VR and mobile solutions enables businesses to bridge the gap between the digital (virtual) world and the real (physical) world. This implies placing special consideration on the user's experience in the digital world by providing only well-done content, as well as ensuring comfort of the user in the physical environment.
- The use cases and case studies indicate that companies are to consider three sizes of mobile VR experience (i.e., small, medium, and large) in order to plan for scalability, and also to ensure that the employees are well-trained when introducing mobile VR to first-time users in order to minimize the risk of having a negative customer experience.
- The benefits of leveraging digital technologies such as mobile VR are only realized upon clarity on the objective (i.e., the 'why'). Digital innovation initiatives should not be treated as a silver-bullet to achieve customer centricity.

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Erik Poppe is a research fellow with the Business Process Management Discipline of the Information Systems School at the Queensland University of Technology in Brisbane, Australia. He looks at improving technological support for human work practice through the application of game technologies and novel user interfaces. His current research focuses on immersive big process data visualizations and remote collaboration using virtual environments and virtual reality.

Désirée Gilgen heads the Presales Innovation for Middle and Eastern Europe with SAP (Switzerland) AG, where she looks at innovative technologies like Mobile Virtual Reality and tools/methods like Design Thinking. Before this she was a solution specialist for Mobility, offering support to companies on strategic and operational issues concerning Mobility Software. She joined SAP more than 2 years ago and has worked and lived in Australia, Hong Kong, United States and Switzerland. Désirée holds a bachelor degree in Business Administration from the Zurich University of Applied Science.

Niz Safrudin is part of the Digital Innovation and Transformation team at SAP Business Transformation Services. She is based in Zürich since 2015, after completing her Ph.D. in IT-enabled business transformation at the Queensland University of Technology, Australia. Her background is in business process (re-)design, and in her present role, she explores with customers and partners how contemporary technologies such as wearables, augmented and virtual reality—when coupled with SAP solutions—can enable companies to re-imagine the way they run their business.

Epilogue

Edward Schreckling and Christoph Steiger

Taking a step toward becoming a digital enterprise is demanding and challenging. This book sheds light on cross-industry and industry-specific trends in digital innovation and transformation and on digitalization use cases. Here we highlight some of the key findings of the contributions to this book.

In the 'Cross-industry trends' part of the book, '*Digitalize or Drown*' stated that digitization, defined as the process of changing from analog to digital form, is inevitable, irreversible, tremendously fast, and ubiquitous. Digitalizing, defined as the process of moving to a digital business, is no longer a choice but an imperative for all businesses across all industries and regions. The dimensions of customer centricity, leadership and strategy, business models, including offerings (products and services), processes, structure and governance, people and skills, culture, and technology foundation can serve as orientation for digitalization.

As Kowalkiewicz, Safrudin, and Schulze emphasized in their article '*The Business Consequences of a Digitally Transformed Economy*', businesses are urged to change while they are still in good shape. Organizations that are already losing market share will face decreasing investment potential, while those who proactively disrupt themselves will reap the benefits of investments and stay ahead of their competition. The fast-changing market and digital economy require a new setup and fundamentally improved capabilities, so digitizing the core technology and, equally important, digitizing the mindset of decision-makers are required.

As Kohnke pointed out in '*It's Not Just about Technology: The People Side of Digitization*', digitization has a strong impact on ways of working, and it accelerates the pace of change that organizations face. These two major implications call for new skills and competencies, new forms of leadership, and organizational agility, which will evolve the organizational culture toward a digital mindset.

E. Schreckling • C. Steiger (✉)
SAP Digital Business Services (DBS), SAP Deutschland SE & Co. KG, resp. SAP SE, Walldorf, Germany
e-mail: edward.schreckling@sap.com; christoph.steiger@sap.com

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As von Kutzschenbach, Mittemeyer, and Wagner state in their article '*Antithetic Leadership—Designers Are Different, Business People Too*', organizations that view the ability to innovate constantly as inescapable build their leadership styles on factors other than business thinking. The impact of this enlargement will transform companies' cultures, and their vision and missions will become multifaceted.

According to '*Digital Culture—Why Strategy and Culture Should Eat Breakfast Together*', by Wokurka, Banschbach, Houlder, and Jolly, culture and strategy should be aligned. The digital culture creates special requirements for customer orientation, organizational design, and the approach to collaboration. Business innovation plays an even bigger role. All of this must be reflected in the digital strategy to ensure a strong competitive advantage.

Blaschke, Cigaina, Riss, and Shoshan show in '*Designing Business Models for the Digital Economy*' that digital transformation requires a methodological approach that integrates technology and business considerations based on a language common to technical and business experts.

In the 'Industry-specific trends' part of the book, Kehr, Tonkin, and Bihler's article '*The Unbanked Don't Need More Brick-and-Mortar Banks*' describes how a shift toward mobile-based banking and other technologies in the context of a developing country is possible only after a company addresses cultural issues and takes the economic and political environment into account.

In '*Digital Supply Chain Management Agenda for the Automotive Supplier Industry*', Farahani, Meier, and Wilke note that supply chain management, as a key business priority of almost every manufacturing company, is at the center of the upcoming digital era, where almost everything will be connected to almost everything else via the internet.

In '*The Value of Lifecycle Information To Transform the Manufacturing Industry*', Gudergan, Buschmeyer, Feige, Krechting, Bradenbrink, and Mutschler find that the creation of industrial product-service systems with information exchange and the use of field service data and engineering aids in generating new business models. An adequate information architecture and the subsequent management model are the key factors in successful implementation.

In the 'Use cases' part of the book, vom Brocke, Fay, Böhm, and Haltenhof's article '*Creating a Market Analytics Tool That Marketers LOVE to Use—A Case of Digital Transformation at Beiersdorf*' describes how digital technology goes far beyond the technology itself by building new digital capabilities in an organization and stimulating a new loop of transformation.

Moyer, Tom-Aba, Sharma, and Krause's '*Taking Digital Innovation into the Field of Infectious Diseases—the Case of SORMAS®*' shows that digital technology and innovative development approaches can protect human lives, especially in countries where infrastructure and access to resources remain a challenge for the foreseeable future.

In '*A Journey of Digital Innovation and Transformation—The Case of Hilti*', vom Brocke, Fay, Schmiedel, Petry, Krause, and Teinzer contend that, while digital transformation should not be adopted for its own sake since it focuses on meeting customer demands and requirements rather than blindly pursuing the latest trends, customers expect these digital offerings, so a company that does not offer them will lose customers.

In '*The Future of Automobility*' Janasz and Schneidewind depict the convergence of digital technologies, shared mobility patterns, and recent advancements in the automation of cars. The authors propose a range of innovative mobility concepts and associated business models for 'automobility', one of which are fleets of shared autonomous vehicles. As these innovation areas are explored by new actors, such as ICT companies, the automotive sector is required to develop appropriate strategies and partnerships in order to be well equipped for the challenges ahead.

Condea, Cruickshank, and Hagedorn's article '*What Co-Innovation Can Mean for Digital Business Transformation—Sharing and Managing Risk to Achieve IT Business Innovation*' discusses how, to achieve the digital transformation, one must change the firm's focus from closed innovation to co-innovation with external parties. Understanding new technologies by co-innovating with other parties improves the participating parties' understanding of the pros and cons of such new technologies.

In '*Virtual Reality Goes Mobile in the Digital Age*', Poppe, Gilgen, and Safrudin emphasize that the combination of digital technologies like VR and mobile solutions enables businesses to bridge the gap between the digital (virtual) world and the real (physical) world. This combination implies the need to place special consideration on the users' experience in the digital world by providing only content that is well done and ensuring the users' comfort in their physical environment.

The articles in this book have touched on all eight dimensions of the digital innovation and transformation framework that was introduced here. The most frequently addressed dimensions are technology foundation and business models, which also constitute Gartner's definition of digitalization that we introduced in the beginning. Other important levers, according to the number of contributions in this book, are leadership and strategy, processes, culture, and structure and governance. All of these digitalization levers aim at raising the level of customer centricity.

Edward Schreckling is Head of Digital Thought Leadership & Enablement (DTL&E). DTL&E focuses on disseminating leading-edge knowledge on digital innovation and transformation, advancing the SAP Digital Business Services portfolio, and delivering world-class trainings for SAP DBS consultants and SAP customers. Before being appointed Head of DTL&E, Edward headed organizational development and managed strategic projects at WITTENSTEIN AG. Between 1998 and 2007, Edward worked for SAP in several positions, for instance, as Business Manager at SAP Business Consulting, and as Head of Strategic Projects and Operational Efficiency at SAP Service and Support. Edward studied business administration at the Technical University of Berlin and holds a doctor's degree from the University of Mannheim.

Christoph Steiger is Global Head of Business Transformation Services (BTS) at SAP Digital Business Services. SAP BTS is a global organization with a local presence in all geographies. It focuses on innovating, transforming and optimizing the business models of SAP's most strategic customers in order to maximize the return from their SAP investment. Before being appointed Global Head of SAP® Business Transformation Services effective October 1, 2015, Dr. Christoph Steiger has been Head of BTS Europe, Middle East and Africa. He joined SAP early 2010 having

spent 18 years in international management consulting firms such as Arthur D. Little, AlixPartners and Accenture where he was in charge of corporate and IT strategy projects, business innovation programs, merger and acquisition, as well as corporate restructuring and turnaround engagements.

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