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Digital Transformation
A Guide for Managers
Groningen Digital Business Centre (GDBC)
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introduction

Digital transformation enabled by digital technologies has led to a multitude of innovations and has changed long-standing paradigms in business and society. The rise of online retailers like Amazon brought an ever-increasing number of items into customers' homes and put enormous pressure on brick-and-mortar shops. Companies such as Apple and Netflix have revolutionized the way media is consumed, while Facebook and Instagram have reshaped how we connect with friends and family. Moreover, technologies such as blockchain not only created a new realm for currencies (e.g., Bitcoin), but are also fundamentally changing the governance of business relationships. On a broader level, the Metaverse is promising to link the physical and digital world in an unprecedented manner. Clearly, the digital transformation of firms and society has put enormous pressure on firms, especially on non- digital native firms and small to medium enterprises.

The way to digital transformation is long and paved with failure. While many professional consulting firms urge managers that digital transformation is not just a fashionable management fad, little is known on how to transform successfully. Even worse, recent business insights estimate that up to 80% of digital transformation initiatives fail to deliver to their promise. The consequences can be dire. When companies miss out on major trends such as digitalization, they can lose entire markets (e.g., Nokia) or be brought to the brink of bankruptcy (e.g., Kodak). This divide between urgency (the need for the latest insights) and what is delivered can seriously hamper a business's ability to transform. And while some anecdotal evidence exists on how single firms managed to (partly) transform their business, little is known about more generalizable and rigorous ways in which digital transformation is changing the game.

This book, which consists of 10 chapters, tries to address the apparent gap in knowledge on how digital transformation and digital technologies are reshaping value creation and value capture. As academics, we are working at the forefront of knowledge, always with the goal in mind that our work can inspire decision-makers. What we realized was that oftentimes our academic outlets are not reaching practitioners in time and are oftentimes written in a way that is not easy to comprehend. Especially for a topic such as digital transformation where changes happen at an ever-increasing speed, this poses challenges. Thus, a key goal of this book is to make state-of-the-art knowledge accessible

to practitioners. A second motivation for us is that academics typically work within their disciplines such as marketing, strategic management, or information systems and rarely cover and integrated insights from multiple research fields. However, digital transformation with its deep changes requires an interdisciplinary approach instead of perspectives from one single domain. Thus, our book also provides insights from experts from a variety of domains. In addition, we keep our efforts relevant for practitioners through collaborations with businesses within some of the chapters (e.g., the chapter on Blockchain with scientists and professionals from IBM).

structure of the book

Part	Chapter	Lessons
A **What is digital transformation and how to get ready for it?** (page 9)	1. Digital Transformation for managers	What you must know about digital transformation
	2. Digital Business Models and Platforms	Everything about digital business models
	3. Digital Readiness	How to get your employees ready
	4. Digital Roadmapping	How to map out the journey to digital transformation
	5. Implementation of Digital Business Models	How to implement digital business
B **Digital technologies and trends and why you should not miss them** (page 121)	6. Digital Governance and Blockchain	How blockchain helps to govern partners
	7. AI and Robotics in Marketing	How service robots help customers
	8. Digital Twins	Why digital twins are a must for your organization's digital strategy
	9. Pricing in the Digital Age	Everything about pricing in the digital age
	10. How Digital Transformation Impacts Consumer Behaviour	Opportunities and challenges concerning customers

This book is structured into two main parts, each part containing five chapters. Each chapter summarizes the key points. This approach should help to make the chapters easily accessible and guide the reader toward the information he/she needs. We have added a brief summary above each chapter.

In the first part of the book, we discuss digital transformation from a general business perspective. We combine insights from experts in different fields such as information systems, marketing, and management. Thereby, we also cover topics such as digital business models and why platforms are becoming more powerful, as well as how companies can become ready for transformation and manage their journey towards becoming a digital company. In the first chapter, we start with a broad introduction to digital transformation and touch upon several important aspects related to change management. Subsequently, the second chapter touches upon digital business models and platforms and discusses the metaverse and other technologies as examples. In the third chapter, the authors introduce digital readiness and make an important step towards discussing the role of employees in digital transformation. The fourth chapter then takes a broader approach to the planning process of how companies can map their journey towards digital transformation. This is one of the chapters with authors from the business practice. The fifth chapter more broadly discusses the implementation of digital business models. Hence, the first five chapters together form a broad overview of digital transformation and touch upon different elements important to successful transformation that help managers make informed decisions.

The second part of the book focuses on more specific elements of digital transformation and specifically touches on different technologies and their implications. Thereby, we provide information about highly popularized technologies, such as blockchain or robotics, and discuss their implications for businesses. While all these chapters have a narrower focus compared to the ones in the first part, they provide highly relevant information for companies that engage in digital transformation efforts. In the sixth chapter, the authors cover blockchain technology and provide information on how blockchain can help to govern relationships between different parties. Thus this is also one of the chapters which was created together with practitioners from IBM. In the seventh chapter, the authors discuss service robots and how customers might react to the usage of them. The eighth chapter takes a much more technical perspective on digital twins and shows how companies can use this technology to create a virtual test case for their needs without needing to employ any changes in the real world. The ninth chapter takes a more customer-centric view and is especially relevant for anyone doing business online as it covers the role of pricing in the digital age. The tenth chapter deals with how digital transformation affects customer behavior and provides practical examples on how firms may benefit from such changes. This last chapter was also written by practitioners' authors, this time from DVJ Insights.

This book provides timely and relevant managerial implications for practitioners who deal with digital transformation. This book was made possible with the help of the Groningen Digital Business Centre (GDBC) and its academic director Tammo Bijmolt. Most authors are affliated with the GDBC and represent a multidisciplinary and international group of researchers who are experts covering a wide range of digital business phenomena and topics. The remaining authors are part of the wider GDBC network and come from institutions within Europe and the US. We hope their insights are useful to our readers and trigger their interest to take the next step in digital transformation. The GDBC is open to exploring new digital business challenges together with local SMEs as well as corporates.

What is digital transformation and how to get ready for it?

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#1

Digital Transformation for Managers

Opportunities, Strategies and Pitfalls

Scan the QR for the animation of this chapter

Nicolai Etienne Fabian (RUG), John Qi Dong (Trinity College Dublin, University of Dublin) and Abhi Bhattacharya (University of Alabama)

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Digital transformation puts enormous pressure on companies to become more digital. By incorporating digital technologies, companies can generate value for their customers in fully new ways. The key to such value creation is the utilization of new digital business models. Depending on the circumstances, firms might offer a part of their products for free, change to a service-driven business model, or create a platform. However, digital transformation remains inherently risky and business model transformation is time-consuming and costly. Managers need to be aware of several pitfalls such as changing organizational structure, culture, and leadership. Moreover, in the transformation process roles of employees also change and some might even show resistance to digital transformation initiatives.

In this book chapter, we discuss digital transformation, digital business models, and potential pitfalls and provide practical guidance for managers. This chapter provides managers with a broad overview of research on digital transformation and accounts from practice.

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The Idea in brief

The Issue	The Response	The Bottom Line
What is digital transformation and how can it generate value for firm?	Digital change occurs in phases and there are various potential digital business models	Digital transformation is risky and time consuming but not transforming is not an option
Digital transformation requires new business models that utilize digital technologies	Changing the business model is a time consuming process that has potential pitfalls	Implemented in the right way, digital transformation makes the company future proof

Why digital transformation is the biggest opportunity and threat for your business?

The digital transformation of firms, industries, and society is advancing at an ever-increasing pace. Digital transformation refers to the integration, use, and exploitation of digital technologies to trigger major changes in value creation, appropriation, and delivery. In the past decade, there have been several calls that becoming more digital is imperative to stay future-proof. Finally, the COVID-19 pandemic and the resulting closures of businesses all around the world showed the need for digital infrastructure as online shops and digital businesses navigated comparatively smoothly through the crisis. In contrast, firms that just started on their digital venture had to adopt digital means of communicating and creating value overnight and often struggled in comparison to their more digital competitors. While another pandemic is hopefully decades away, the need to become digital is not going away anytime soon. Hence, digital transformation will remain a key point on the agenda for executives to guarantee that their businesses stay future-proof.

Integrating digital technologies to create an online offering was used by many small to medium enterprises during the worldwide pandemic. From one day to the other, many small firms such as restaurants were cut off from any income stream and managed to switch towards online ordering systems to deliver food to their customers. While this new means of value creation often were not enough to replace the entire income stream, digital technology helped these firms to at least create some income despite being unable to open their doors. Aside from forced digital transformation, there are also more deliberate (digitalization) journeys about local firms.

For example, the German company “Holzgespür” offers custom-made dining tables that can be ordered on an online website (Holzgespür, n.d). The company was founded by Julia Kasper, who created it as a branch of the already existing carpentry company of her family. The SME successfully integrated the website for custom-made tables within their existing local (non-digital). As part of the offering, the carpenters do use digital technology not only to get orders but also to connect with the customer and update them on the progress of their ordered products (Storn, n.d.). The new digital branch of the existing carpentry company accounts for a significant share of the income (roughly one- third) and is a prime example of how the integration of digital technology to existing SME companies can create new business opportunities. While it might be debatable whether this counts as full-scale

digital transformation, it shows the potential of integrating digital technologies to existing businesses and thus a potential pathway to future digital transformation efforts.

What makes digital transformation both a big opportunity but also a high risk strategy is that it can change the course of the company. If successful, digital transformation can lead to fully new opportunities such as in the case of "Holzgespür". However, if unsuccessful, digital transformation can lead to a company's demise. Hence, executives nowadays are in jeopardy between transforming to become future-proof on the one hand and risking demise on the other hand. On the bright side, digital transformation is possible and with this book chapter, we try to equip businesses with the latest knowledge from academia, packaged in a way that is easy to grasp and helpful for business.

What is digital transformation?

Digitization	Digitalization	Digital Transformation
• Transform analog to digital information • Basis for other phases • Focus on saving costs • E.g., from paper files to electronic files	• Transform analog to digital processes • Smaller scale change • Focus in increasing efficiency • E.g., establish online shop	• Full scale change of business model • Most pervasive form • Focus on transforming the renewal model • E.g., from product to Software-as-a-Service

Aside from digital transformation, there are two other relevant and often overlapping concepts: digitization and digitalization (Verhoef et al., 2021). The first term digitization refers to the transformation of analog to digital information and serves as the first phase of digital change. To some degree, digitization reflects the basic necessity for digitalization and digital transformation. In practice, digitization can mean that paper forms are replaced by digital forms such as for employees registering their holiday days in a system. Second, digitalization refers to changes in (isolated) processes that are becoming digital. Digitalization refers to the second phase of digital change and is for example used to streamline ordering processes for goods, including online shopping as an additional channel or streamline internal process management. Digitalization is often needed as an interim step towards digital transformation.

The third and most pervasive phase of digital change is digital transformation. There are a lot of different and overlapping definitions from academics, businesses, consultants, and other interest groups. For the definition, we draw both on our published work (see Verhoef et al., 2021) and other recent advances from both academia (e.g. Hanelt, Bohnsack, Marz, & Antunes, 2020; Vial, 2019), but also through experience gained through the Groningen Digital Business Center (GDBC). Thus, for the working definition, we can merge a thorough academic perspective with the necessities for practical use from the business side. This way of defining digital transformation is unique to the way the Groningen Digital Business Center works and helps to tackle the broad meaning and implications it has for business. We define digital transformation as "a firm's change in the utilization of digital technologies to create new ways of value creation and appropriation and, thus, to develop a new digital business model" (Verhoef et al., 2021).

The three definitions together show a clear path on how companies can proceed. When regarded as three phases of digital change (Verhoef et al., 2021), each phase provides different chances and opportunities. While in the first phase, cost saving is the most prevalent objective, it also provides new opportunities to work with the digital data. Moreover the second phase already allows for a wide range of improvements and potential new sources of value creation. In addition, the knowledge gained through these two digital phases allows companies to proceed with full scale digital transformation efforts. As a disclaimer, it must be said that these phases cannot be seen entirely as separate stages but that elements can also overlap and that it is possible (though unlikely) that stages might be skipped entirely.

While technology, as outlined above, plays an important role in digital transformation, it is by no means the sole cause of digital transformation (Verhoef et al., 2021; Vial, 2019). In other words, a company can acquire a range of new technologies, but without the ability to use them in new ways to create value, it is no digital transformation and likely the fastest way towards bankruptcy. While in the old economy (before 1990), the possession and control of unique resources such as machines were key to gain a competitive advantage there is a striking difference today. In the digital economy, most resources are readily and easily available for little to no cost. Even sophisticated AI and machine learning algorithms are freely available. For example, the self-driving mode from in Tesla cars is based to a great degree on open-source Python libraries such as PyTorch or TensorFlow (Sagar, 2019). A disclaimer, the training, and development of an AI is still extremely expensive and time-consuming, but the "technical" ingredients that make these new recipes (i.e., innovations) are readily available. With the right human capital (e.g. engineers and data scientists) as well as time and training data, everybody could potentially

recreate the same technology. Thus, the importance of physical resources – in this case (digital) technology – decreases, while the importance of human capital that handles such technology increases. Thus, digital transformation is about the ability to use technology for value creation and not the technology itself.

What are digital business models?

For digital transformation, the important term to discuss is business model change. The term business model refers to the way how a business creates and delivers value to customers and subsequently converts payments to profit. In other words, a business model describes how the company makes money (Teece, 2018). In this sense, thinking about the business model is literally the most important task when thinking about digital transformation and becoming future-proof. Without a solid working business model, a company will sooner or later go bankrupt.

In contrast to established business models, digital business models differ in several key areas. Many of the currently most successful business models would have been impossible to realize without having the right technology available. Imagine a paper shopping catalog trying to imitate the tens of thousands of items of Amazon. This catalog would have been so heavy that no customer would be able to browse through it in a reasonable time. Thus, digital technology (search functionality, virtual product space) is the key enabler of new possibilities to generate value. There are many different digital business models. While some such as platforms are prone to be applied by bigger companies (e.g. platforms), also SMEs must consider how to compete in a digital marketplace. Not only that digital business models are more profitable, but they are also key for SMEs to defend themselves against bigger companies and to stay future-proof.

To provide an overview of some of the most common digital business models, we outline below how these business models work, how profits are generated, and what is unique about them. Besides, we will provide specific examples of firms that operate such business models. This list does not cover every potential digital business model, and each model may not be suited for every company. Sometimes a combination of two, or an addition to the existing business model works best for established companies. Furthermore, it does not cover smaller level additions from digitalization such as webshops. Nonetheless, the list provides an example of how digital technology can be used to fuel the development of new business models.

Table 1. Overview digital business models

Business Model	Strength	Weakness	Costs and Revenue	Suitability
The freemium model	A potentially large market and large margins if established	Only profitable if a sufficiently large part of customers pays a premium	Sufficient investment required to build a user base for both free and premium product	Suitable for SMEs and multinationals alike
The "free" product or service	Especially for SMEs and startups, easy to get started (e.g. affiliate marketing)	A target market needs to be identified and profit requires significant time investment	Potentially low investment required to get started but substantial time (and money) to grow a userbase that generates revenue	More suitable for SMEs or startups
Subscription and/or pay per use	Steady and more predictable income stream	Transition time is costly and time consuming and requires major changes in the business	Moderate investment and revenue opportunities	Suitable for SMEs and multinationals alike
Software/Something as a service (SaaS)	Scalable business model	Customer service is key to establish the business model	Moderate to high costs to establish, but steady revenue	Suitable for SMEs and multinationals alike
Moving up or down the value chain	Vertical integration leads to more control over the value chain and potentially to a higher share of profit for one company	Time and investment required to cut out the middleman	Moderate to high investment and time required to build necessary capabilities	Suitable for SMEs and multinationals alike
The platform-based business model	Highly scalable, low running costs, and huge profit potential	Requires a sufficiently large user base to be profitable and create value	Huge investment needed to grow market but scalable and highly profitable if large installed bases are established	More suitable to multinationals but also for SMEs and startups in niche markets

1. The freemium model

The freemium business model is characterized by the combination of a free service or product with the option to buy a premium version of the same product or service by paying extra. Here, the company offers a product or service without charge, but customers can buy a premium version of the service for a fee. While the free part of the offering is aimed at getting customers to the website/platform/to the service, the company often does not earn money with those customers. Henceforth, once customers pay for additional features, the company can make a profit. Research from the video gaming industry demonstrates that the offering has to be of higher value than comparable premium products of competitors to be profitable (Rietvield, 2018). Distinctly for this digital business model is the fact that the marginal (distribution) costs to serve the next customer are close to zero. Once the offering is set, more customers can easily be added. The downside is that this business model relies on considerable market size or needs to operate in a market niche or segment that is big enough to sustain a company (e.g. in the video gaming industry a specific niche such as middle age strategy games).

Dropbox applies the fremium business model. The rudimentary service is for free, yet it allows customers to store additional data and greater sharing and accessing opportunities in the cloud when customers pay a subscription fee. For the free service, the storage space is strongly limited and does not allow the customer to put a lot of data in the cloud. Thus, Dropbox offers different versions of its storage with increasing costs for more storage space. Another Mailchimp in the marketing automation business, which offers a rudimentary service for free but offers premium services with more functionality for a premium.

2. The “free” product or service

There is a saying that nothing comes for free and especially with digital technologies, there are services that users are gonna pay for, one way or the other. In this business model, the firm offers a certain service or product without any charge. Also, there are “no hidden” costs because the entire service is offered without any charge to the customer, unlike the freemium model in which additional functions cost extra (see above). However, in this business model, the company earns money based on at least one of three bases. First, they generate value by using customer data. Second, the firm earns money through ads. Third, they earn money through commission (e.g. affiliate marketing). Sometimes, those models are combined and through the available data more fine-grained offerings are available. There are some costs involved to set up a “free” service or product, but once established the marginal costs of adding additional customers tend towards zero meaning that these business models are extremely scalable.

Clear examples of the free product or service include the search engine Google or social networks such as Facebook, Instagram, or TikTok. In any case, they are offered for free but earn money through using customers’ data for advertising. On a smaller scale, web blogs often for niche topics are offered for free and can also earn a substantial amount of money once sufficiently enough users come across the website. For example, the dutch SME Elevar BV with its website 123tinki.nl provides a huge blog archive with nearly any information about dogs. While they do not earn money with the blog, the company provides a price comparison tool for any pet products, which is their main source of revenue. In other words, the “free” blog gets visitors on the page, and through affiliate marketing (providing a search tool), the company can earn money from commission.

3. Subscription or pay per use

Today, manufacturers shift from the delivery of physical products to but allow customers to use them by paying for the use or availability to the product. Thus, for this business model, companies no longer offer the product but access to the product by charging a monthly fee and/or charge per-use. This model is rather similar to the rent/leasing business model. However, when renting or leasing an item, the contract duration is usually longer than in the subscription/pay per use business model (compare weeks against months or years). The company earns revenues through the service of providing a certain good or service. The upside of this business model is that it does not necessarily require unstable product sales but rather the creation of a stable customer base that purchases regularly. On the downside, a substantial customer base is needed, and enough products need to be available to sustain peak moments. Moreover, the transition towards subscription is time-consuming and costly (Chao, Kiermeier, Roche, Sane, 2017)

Netflix uses this subscription model by charging a monthly fee that allows the user to conveniently access the entire film database at any moment. Carsharing providers also offer access to cars against a fee for the actual use. Moreover, even car companies are beginning to offer subscription models in addition to leasing and selling cars. On a smaller scale, the German startup/SME HelloFresh offers cooking boxes with changing recipes in a subscription model while the Dutch startup Swapfiets offers a bike against a monthly subscription fee. Thus, this business model is interesting for a wide range of companies that want to extend their current product offering.

4. Software/Something as a service (SaaS)

Service-based business models rely on the idea that companies no longer provide a product but replace their product by providing a service that covers the need of their customers. The model’s prominent use is in the realm of software where companies no longer provide

and sell a disk with a license once to their customer but instead offer their software as a solution that can be used against a fee. While there is some overlap to subscription models, often the SaaS business models are fully developed end-to-end solutions. In the software realm, this means that the SaaS software is accessed remotely and the customer does not need any installation or servers to host the software. In contrast to subscription models, the range of the solution is oftentimes bigger and more used within B2B contexts in contrast to the more customer-focused B2C subscription models. The general idea is to move away from products towards solving customers' problems. Rather than serving off-the-shelf physical products, providers instead offer more customizable services for or solutions to the customer.

Salesforce, a company that charges a monthly fee to allow users to access their full customer management application. Salesforce offers a full-service solution to potential customers. Another example involves IT hardware companies that moved towards offering solutions for example to move the data to the cloud and manage the cloud instead of selling physical server farms. Groningen-based Bossers & Cnossen is an example that transformed from selling and delivering physical products to providing full-service solutions for the clients.

5. Moving up or down the value chain

Organizations can introduce new business models by altering the traditional roles of manufacturers, wholesalers, retailers, and customers. Instead of following the value chain and only selling to the next part, companies that follow this business model use technology to bypass or cut out parties of the value creation. In other words, organizations engage in vertical integration by entering a stage in which they were not active before. Thus, a bigger part of the control and potential profit is concentrated at one company instead of being spread among different companies. While it might be debatable if cutting out the middleman is a business model in and by itself, but with the use of digital technology it was never easier for manufacturers to reach the end consumer without the need for the middleman. The business model provides potential revenue because already existing profit is combined with cost savings due to cutting out a party. On the downside, this strategy might be risky if the middleman possesses specific resources that cannot easily be build such as an extensive network of long-lasting relationships (Broekhuizen, Lampel, & Rietveld, 2013). Hence, while there is potential it does require time or might not even be viable to cut the middleman out.

One major benefit of bypassing parties like wholesalers and retailers through setting up an online shop and selling directly to the end consumer is the opportunity to offer cheaper prices because the middleman no longer needs to be paid. The company gains a bigger share of the profits because it no longer needs to share the profits with other parties. The potential downside is that money needs to be invested to get to the end customers (e.g. getting visible on Google). When organizations succeed, an additional benefit is that it gains more control over the customer experience and can establish close contact with the end customer.

6. The platform-based business model

Platform-based digital business models appear in different shades but at its core, platforms facilitate interaction between different parties such as consumers, producers, and/or third-party actors (Constantinides, Henfridsson, & Parker, 2018). In two-sided markets a platform connects distinct user types like demand and supply. Uber functions as an intermediary and connects buyers (i.e., those who need a ride) and suppliers (i.e., those who can give a ride). Moreover, the company might also create a platform for buyers and sellers and offer their own products (Amazon), or create a platform with its own products that also allows third-party services (Appstore). In all these cases, the connection between parties is made through a digital interface, like an app or a web portal, or a combination of both. The model can be beneficial cost-wise because often it does not require a large workforce to run the platform. However, investment costs can weigh heavy because a substantive share of the market must be covered to be profitable, and often price wars between competitors can easily kill margins and cause market exits (for example the price war between different food delivery platforms). Lastly, once established, the platform company generates revenue and profits by getting a fixed percentage of the payment for the service. Often these payments make up between 10% - 30% depending on the costs of the good, and the market power of the platform. Hence, the bigger the potential market and the more dominant the company is, the more profit is possible and the harder it is for incumbents and new entrants to fight against this model.

The classic examples for platforms include the large American companies such as Uber, Airbnb, or Amazon that rely to a great degree on venture capital. For that reason, it is oftentimes assumed that this business model is not suited for SME companies. However, also SMEs can create platforms. An example is the German website "materialrest24.de" which offers a platform for craftsmen to sell leftover materials (Storn, n.d.). Through this website, craftsmen can either sell material they have leftover or buy material in smaller quantities than usually at wholesale stores. While the craftsmen market might not appeal to American multinationals, it is a prime example of how digital technology can be used to create value by and for small to medium enterprises.

Pitfalls of digital transformation and how to avoid them

Table 2. Dangers and solutions of digital transformation

Pitfall	Potential Danger	Potential Solution
Organizational structure	Established ways of working often too slow (bureaucratic)	Establish agile working structures to react to changes faster
Organizational culture	Product culture may not be suitable for digital services	Feedback and customer-centric culture needed that promotes openness to digital
Leadership	Without clear direction, resources might be wasted	Establish a digital specialist or leader to champion change
Employee skills and roles	Routine work may be automized by AI, or certain roles are no longer needed	Focus on human soft skills and retrain employees with online courses
Inertia	Fixed work structures that are hard to change	Establish separate units to learn and expand them slowly
Resistance	Employees may resist change	A combination of leadership, training, and separate units needed

Digital transformation entails several pitfalls. As digital transformation requires a substantial change in the business to utilize those technologies for new means for value creation, there are important factors to consider. The success of undergoing digital transformation also depends on how well they manage structural changes as well as how they deal with organizational barriers (Vial, 2019). While those concerns may seem more relevant for bigger firms, also SMEs have to deal with several of these dimensions when integrating digital technology within their offering (Storn, n.d.).

First, structural changes are required for digital transformation and those substantially influence how companies might succeed in changing their business model (Vial, 2019). Among those structural changes is organizational structure. One big trend coming from software development to regular project management is the Agile movement. As part of this movement, companies work with faster feedback circles, more interdepartmental collaboration, and the possibility to experiment and end unsuccessful experiments if necessary. These agile methods can also be incorporated in general organizational structure and for example, facilitate the use of cross-departmental teams. In consequence, products are no longer created by engineers alone but through combined input from for example the marketing or IT department. Following organizational structure are changes to organizational culture (Vial, 2019). Especially for an agile way of working but also for cross- departmental collaborations changes in organizational culture are needed. Employees must adapt to a new culture that decreased bureaucracy while increasing agency for each individual. Also, tolerance for failure and admiration for trial and error is deemed important to survive in a fast-paced environment. Lastly, digital needs to become a part of a company's DNA, meaning that everything in the company is entangled with digital technology. While all these changes require a huge change in the organization and can be facilitators for change, they can also hinder change.

Potential solution:
From research, we know that organizational structure can be changed relatively quickly (at least on paper). For example, ING bank changed towards an agile way of working within months (McKinsey Quarterly, 2017). However, corresponding changes to culture often happen over years and require a much more long-term view. Moreover, cultural changes also go in hand with instability as well as a part of the workforce leaving. Thus, managers need to be aware that culture can severely hinder digital transformation in their companies. A long-term vision and plan to change culture is needed and often smaller-scale units that operate outside the company's bureaucracy are advised to get started and learn how digitally transform (Tumbas, Berente, & vom Brocke, 2018). Thereby, companies can slowly grow their more digital operations without interrupting or disturbing existing means of value creation.

The third structural element is leadership (Vial, 2019). Especially in times of crisis strong leadership is needed to rally the organization behind. But leadership also plays a key role in facilitating change when seeking opportunities (Storn, n.d.). Therefore, companies need to provide a strong sense of direction and allocate responsibility to distinct managers. Especially useful in that regard are Chief Digital Officers (CDOs) (Kunisch, Menz, & Langan, 2020). There is strong evidence in the business literature that CDOs can severely impact how companies manage digital transformation by allocating responsibility to key individuals. The use of CDOs will also be later discussed as a potential strategy to deal with digital transformation. Aside from leadership, digital transformation also requires changes to the workforce (Vial, 2019). It is estimated that through technology such as AI,

thousands of highly qualified jobs can be partly or fully automated (Dengler & Matthes, 2018). Think along with repetitive work that requires individuals to follow a strict set of rules such as in law or accounting. These tasks currently done by university-educated professionals are increasingly under pressure to be done by AI instead. For example, Flightright developed an AI-powered business model around an EU regulation that allows passengers to get reimbursement from airlines in case their flights are delayed by more than three hours. Instead of employing lawyers to decide whether a claim might be just, they utilize technology to classify claims and can use their workforce instead for court battles for the cases that are winnable (Kaplan, 2019). In turn, companies face immense pressure to reeducate their workforce for the demands of the digital age, and many professions might require a completely different skill set in the coming years.

Potential solution:

To guarantee that change is properly executed and that responsibilities are clear, smaller firms can use digital specialists. A digital specialist is broadly defined as somebody responsible for managing digital topics and thus the person to champion change and the first contact person for employees in case of doubt. We found that digital specialists can help to unlock the financial potential of digital transformation by facilitating change and setting clear responsibilities (Fabian, Nguyen, & Broekhuizen, 2021). Moreover, to address changes in roles and skills, companies can use two strategies. First, they can make use of non- traditional ways of upskilling their workforces such as online courses or mini university degrees. These courses allow employees to gain new skills without the need for three-year full-time university programs. On top, while repetitive tasks can be automized, more time is available for face-to-face client interactions, which opens fully new possibilities for companies to connect with their customers.

The second organizational barrier deals with inertia to change and resistance to change (Vial, 2019). Inertia and resistance are not limited to large organizations implementing change, but also found within small firms (Storn, n.d). Research on IT implementation shows how employees react to sudden change such as the implementation of new IT. Similar reactions are likely when it comes to digital transformation. The first barrier to change refers to inertia and refers to the difficulty to move and adjust in a changing environment and thus to continue working in a set way. In this regard, firms often have established long-term relations with their customers and built-up routines to complete tasks, which often impair quick changes. Moreover, inertia is also strongly associated with culture, if the culture is long-established and engrained, employees are more prone to inertia than in rapidly changing environments in which change and evolvement are constant. The second barrier to change is resistance by the workforce (Vial, 2019).

Workers can resist change passively, actively, but also aggressively, which then turns to open hostility. Previous research on IT implementation shows that resistance is one of the key determinants of project failure. Resistance often originates from individuals and subsequently affect entire teams (Lapointe & Rivard, 2005). Once teams resist, it is hard to counter resistance and get employees to support the change. Hence, managers who want to engage in digital transformation are advised to consider and do their best to mitigate the inhibiting key factor of resistance.

Potential solution:

At first, managers need to understand that humans are creatures of habit, thus inertia and resistance are a sign that employees might be overwhelmed. Thus, for established firms, it is often advisable that sufficient time is planned to implement change. Moreover, change should be well com municated, planned and sufficient support for employees needs to be provided. In practice, often firms start the change by establishing separate units that operate outside of company rules and bureaucracy. Through these separate units, learning can be facilitated, and change happens more slowly and organically. Moreover, clear
communications and leadership have been found to help employees to adjust to the new situation. Lastly, if new ways of work are required, companies should provide sufficient opportunity to train and prepare the workforce for the change. In this regard, if resistance and criticism start, it is important to devote time and effort to get everyone on board as rooting out resistance on the individual level is much easier compared to at the team level (Lapointe & Rivard, 2005).

Is it worth it?

One of the key questions for digital transformation, in the end, is whether all the trouble is worth it or that digital transformation might just be another management trend that will pass. There are several answers to that question, but the surmounting evidence suggests that digital transformation is not just a trend that will quickly pass. In essence, digital transformation might even be considered as another industrial revolution and certainly have a long-lasting impact on society. Getting ready for the digital world is essential to become future proof as in the past adjusting to steam, electricity, or telecommunication. Moreover, many companies currently undergo digital transformation and CEOs communicate their effort as a must to be future proof. Thus, in this regard digital transformation is worth it just to level the playing field.

Secondly, digital business models are the cornerstone for several of the most successful companies on the planet. The majority of the American Fortune 500 index with heavyweights such as Facebook, Amazon, Apple, Netflix, or Google or in the Chinese market with players such as Alibaba or Baidu, or Tencent successfully adopted such digital business models. But also SME firms are transforming their business models. Digital transformation allows new ways for SMEs to create value and connect with their customers. The German website mentioned in the introduction is a prime example on how digital technology enables new means of value creation and opportunities. The digital branch of the carpentry selling custom made tables now contributes roughly one-third of the total profit (Storn, n.d.). Moreover, digital business models and technology ensure survival. The German B2B company WLW (German abbreviation that stands for Who Delivers What) offered a catalog for purchasing industrial goods since 1932. Through digital transformation, they brought their business model to the 21st century and now offer a platform with an integrated search function effectively connecting buyers and suppliers in the market of industrial B2B supplies (Sywottek, n.d.). By implementing major changes to the business model and moving to an intermediary position, the company avoided the threat by big corporations that offered search as part of their business model. Hence, through digital technology, WLW is now able to compete in a digital market and to offer unique value for their customers.

Third, while academic research on the performance implications of digital transformation is still scarce, there is an increasing number of studies that empirically assess whether digital transformation pays off. For example, in our research, we conducted a study on the financial implications of digital transformation and the presence of digital specialists for SME firms (Fabian, Nguyen, & Broekhuizen, 2021). We found that digital specialists in SMEs help firms unlock the financial benefits of digital transformation. A similar observation was made when examining the emergence of Chief Digital Officers in large US firms (Kunisch et al., 2020). These authors found that CDOs have a positive impact on firm performance and help to navigate the tension caused by undergoing digital transformation. Hence, digital transformation is a risky endeavor but the returns are also higher. Research further shows that there are ways to lower the risk and increase the likelihood of success.
In sum, digital transformation is not another trend, it is a necessity to stay future-proof and ready for the next digital decade. Moreover, digital business models have a large profit potential also for smaller firms and allow fully new ways of value creation. Last, undergoing digital transformation is beneficial also in financial terms and firms should not be afraid to undergo the struggle. Given, some firms will fail but if undertaken carefully, digital transformation can be worth the struggle.

Conclusion

This chapter embarked on a journey to investigate what digital transformation is, what its pitfalls are, and whether it is worth it. The goal of this chapter was not to provide a deep academic analysis but rather present recent academic insights comprehensively. Thereby, it makes rigorous and theory-driven academic research accessible for a broader public and aims to help managers make informed decisions about digital transformation. For all the main points raised illustrations and tables were prepared to convey the key points of our analysis.

In the first section, the distinguishment of digital transformation into three phases of digital change is outlined. Namely, (1) digitization that characterizes the transformation from analog to digital information, (2) digitalization to describe the change to digital processes, and (3) digital transformation as full-scale business model transformation. Moreover, the necessity to gain knowledge through these phases and potential overlap is outlined. Subsequently, common digital business models are outlined and explained to provide more basis on how digital transforming the revenue model could look like. Lastly, the key challenges for digital transformation to undergo digital transformation are outlined. This provides a summary of why digital transformation are risky but also worthwhile to pursue.

In conclusion, the chapter provides a short but comprehensive overview of key aspects of digital transformation. Especially the pitfalls and countermeasures might prove useful as they are the key aspects that inhibit value creation and appropriation from digital transformation. We hope that our chapter contributes to the success of digital transformation within your organization.

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#2

Digital Business Models and Platforms

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This chapter illustrates the role of digital technologies in the evolving digital environment and the new business models that are being created in that environment as new digital technologies emerge. The chapter describes the evolution of different types of platform models including search engine platforms, social media and chat platforms and e-commerce platforms and shows how businesses can use these models to their advantage. The chapter also discusses the metaverse as a new form of platform model. The chapter outlines how the notion of product is servicitized through digital services. This opens up opportunities for Internet of Things (IoT) models through networked services and rental models. The development of new pricing models is explored through a discussion of freemium models and subscription models. The chapter then provides pointers for businesses seeking to adopt these models.

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The Idea in brief

The Issue	The Response	The Bottom Line
Digital technologies have changed the competitive landscape, levelling the playfield, creating new players and business models. New forms of institutions and business models called platforms have emerged that have usurped the advantages such technologies can provide firms and have created near monopolies that threaten conventional businesses.	The same technologies have provided opportunities for firms to transform their product, pricing and channel strategies and to create new business models: serviticizing the concept of a product, creating product lines that vary in content and quality, freemium models and subscription models.	Firms should be creative in using digital technologies to create value for their customers directly and in disintermediating platforms and acquiring customers efficiently, building customer lifetime value and creating firm value.

Introduction

The advancement in digital technologies over the last decade has transformed the business landscape substantially. Digital technologies have created a new environment of opportunities for consumers as well as businesses, have changed the competitive landscape, levelling the playfield, creating new players and business models. The environment within which businesses strategize and create their business models have changed drastically in the past decade. The conventional environment consisting of the five Cs – customers, collaborators, competitors, context, and the company – have new forms of institutions. Traditionally, a firm develops its business model by analyzing the environment within which it operates and making the aspiration decisions of how to segment the market and targeting the right segments with an appropriate positioning strategy. The action plan, consisting of product, price, promotion, and distribution strategies, is developed in such a way that it aligns clearly with the target market. These strategies and tactics impact the business outcome in terms of impacting customer acquisition, retention, and margins and firm level metrics of sales, profits, growth rate, brand equity, and market position. Digitization has altered the environment, the strategic decisions and business models in significant ways (Kannan and Li, 2017).

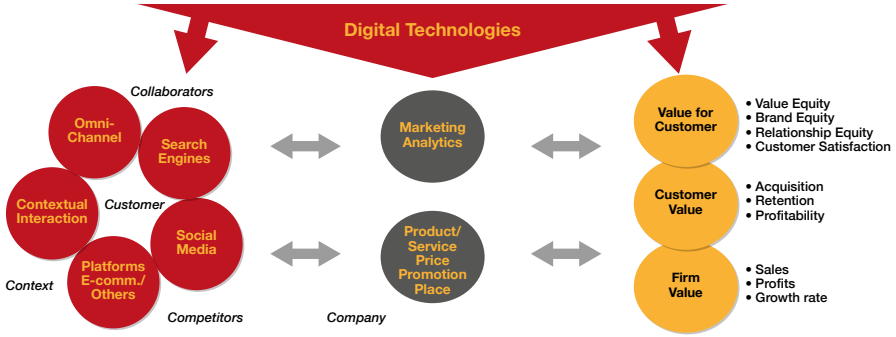

Figure 1: Evolving Framework for Digital Business Models

Figure 1 provides an overview of how digital technologies have changed the environment with the emergence of new forms of institutions. The environment (the block on the left Figure 1) illustrates these new forms of institutions. The block on the top shows the how digital technologies interact with the environment, creating these new institutions - multi- sided platforms such as social media platforms, e- commerce platforms, and search engine platforms along with ubiquitous connectivity provided by mobile devices and

affording integration with offline channels leading to omnichannel options. The interactions with these forms of institutions is guided by the contexts within which markets operate – geographical, cultural, legal and privacy contexts. These combine to provide different options and opportunities for business models.

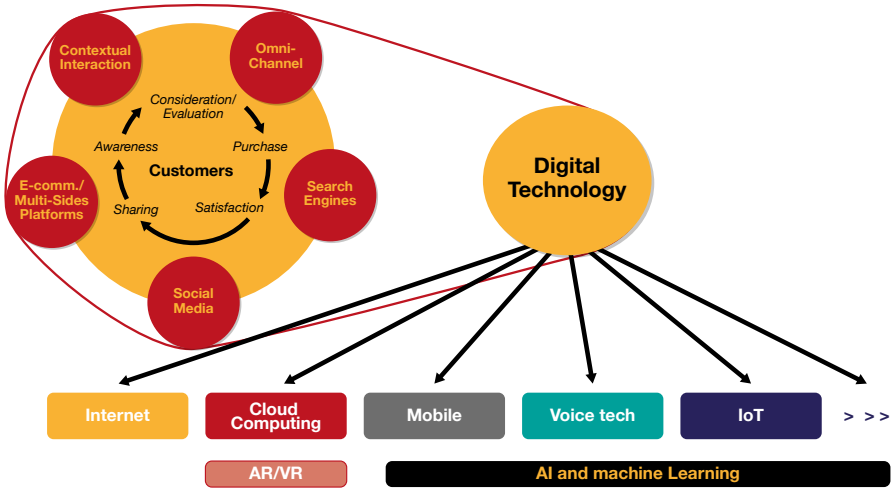

Figure 2: Digital Technologies and Digital Environment

Digital technologies are rapidly changing the environment within which customers interact on their paths to purchase. Digital technologies are reducing information asymmetries between customers and other players in the environment and providing customers with many alternative touchpoints on their customer journey (see Figure 2). This affects customers' information acquisition on quality and price, their search process, their expectations, and the resulting implication for firms. Digital technologies facilitate customer– customer interactions through online media – word- of- mouth, online reviews and ratings, and social media interactions – on social media, chat, and e- commerce platforms. These platforms act as collaboration enablers that connect a firm to its market using digital technologies. Likewise, search engines act both as collaborators with firms and as platforms on which a firm competes with other firms in acquiring customers. Omnichannel options are facilitated by ubiquitous connectivity through network and Wi- Fi connections, mobile devices and watches, and the associated infrastructure such as 5G telecommunication provide customers with access to markets and information wherever they are, transcending contexts. It also provides firms with location- aware capabilities to track customers and reach them whenever and wherever they are.

Digital technologies and the digital environment have transformed the customer journey in an omnichannel setting. Customer awareness can arise from alternative sources – through search engine, social media, and e- commerce platforms, through word- of- mouth or direct- to- consumer messages, through offline or online or mobile devices – multiplying the channels through which consumers can consider, evaluate, and purchase products and services. Likewise, the environment also provides multiple options for firms to target and communicate with their potential customers. As newer technologies emerge – voice technologies, virtual reality and augmented reality, and the Internet of Things (IoT) – channels proliferate. All these provide opportunities to create new business models and strategies.

Digital technologies also increase the capabilities that a firm has in collecting, processing and using market and customer data and provide them with new business models based on personalized offerings enabled by AI and machine learning. They create newer forms of products combining them with services. This is especially applicable to content offerings. Digital technologies also facilitate new pricing models such as freemium models and subscription models. They also facilitate newer forms of channel bundling and fulfillment. All these lead to possibilities for significantly positive outcomes in terms of value creation for customers as well as value creation for firms. In the upcoming sections, we describe the various business models enabled by the digital technologies and digital environment.

Platform Models

A platform business model facilitates interactions across a large number of participants on a platform supported by a technology infrastructure that provides connectivity between participants. The interactions could be of many kinds – a short-term interaction like in a search engine where participants looking for information/products are connected to information providers and retailers or a longer-term interaction like on a B2B platform or social media where participants are connected on a long-term basis. Platforms create value by reducing search costs or transaction costs or both, specifically through network effects. The platform model is different from a traditional business model or a reseller. A traditional business creates or manufactures products/services using raw material or other input and market it to customers. A reseller buys the products from manufacturers and sells it to customers. A platform, on the other hand, does not create the product/service but facilitates the connection between the interested parties. The platforms provide a governance structure, standards and protocols to facilitate the appropriate interactions

and functioning of the platform. The success or failure of a platform may depend significantly on the governance structure (Hagiu 2014).

The digital environment has given rise many different forms of platforms ranging from search engines, social media platforms, e-commerce platforms to learning platforms. The type of participants could range from two (two-sided platforms) to many (multi-sided platforms). The platform could generate revenue by charging all the different types of participants or just one type of participant and providing free access to others. We discuss a few of the important ones below.

Search Engines

Search engines connect users who search for information to the sources of the information searched for. While search engines are free to use for users and for businesses which are connected to users through organic listings, they generate revenue through paid search for which businesses, wishing to attract potential customers searching for related terms to their websites, pay for the clicks for their sponsored ads. The search terms users use helps the businesses to target the right customers to attract. Businesses bid against each other to get top spots in response to users' search terms and a greater competition among businesses for sponsored ads increases the search engine's revenue. Companies like Google, in addition to being a two-sided platform for connecting users with businesses, also act as a multi-sided platform in helping businesses target users at various publisher sites, through display advertising. The publishers (websites) publish content that is relevant for users who visit the website to consume the content. Google targets these users on behalf of businesses, who pay for the display ads. The publishers are compensated for their ad space. Users are exposed to the ads that businesses want to shoe them. Of course, the whole display ecosystem consists of large number of players but this simplified description shows the power of multi-sided platform businesses.

Social Media Platforms

These platforms (e.g., Facebook, Instagram, TikTok, YouTube, Twitter) connect users to other users through social networks and the users consumer the content other users create. Given the significant visibility the platforms have into users' interests and preferences through the content they interact with, these platforms are able to target users precisely for the businesses who want to advertise to the users. This is also the key way they monetize the platforms. The biggest challenge for these platforms in recent times is the backlash with regard to the negative impact of social media on the users (especially young adults), creation of filter bubbles, and indiscriminate use of user data compromising their privacy.

Many of the social media platforms have also evolved over time to multi-sided platforms where they not only support businesses to advertise on the platforms but also sell through the platform. For example, social media platforms such as Douyin in China and TikTok are increasingly support businesses to do live commerce (Gu et al 2021), where influencers on the media pitch products to their followers. Influencers can be seen as a different type of users, ones with large following, that bring in revenue not only for themselves and for the businesses whose products they pitch but also for the platforms too (Haenlien et al 2020). Social media and chat platforms are fast morphing into e-commerce platforms using the influencers in a significant way to make such transformations.

E-Commerce Platforms

When the digital environment opened up opportunities for e-tailing, a number of online retailers sprang up online – Amazon and Alibaba, to mention a few. As these online retailers became behemoth brands attracting millions of visitors to their websites, these online transitioned into e-commerce platforms, where smaller retailers can set up online shops and market to the millions of visitors within the walled garden. In addition to marketing their own products to the customers, these platforms allow other sellers on their platforms to market their wares to the customers. Some of these platforms such as Alibaba also serve as B2B platforms, allowing industrial buyers to identify suppliers and forge longer-term relationships with them. Essentially such platforms become marketplaces controlled by platform owners to facilitate transactions. Platforms like Alibaba have evolved into larger ecosystems encompassing many business as well as payment functions, hosting players in large multi- sided platform. As with social media platforms, e-commerce platforms are also experimenting with live commerce involving influencers to market to their customers.

There are many other platform models that bring two or more parties together for short-term interactions – like eBay for peer-to-peer transactions, AirBnB for rental owners and renters, Uber and Lyft for connecting drivers with passengers, gaming platforms like Xbox and Twitch to connect game developers and game players, etc. All these platforms can be viewed as aggregation platforms by aggregating supply and demand so that the marketplace transactions become efficient as the network effects create significant value for either party to be on the platform. Other kinds of platforms mentioned in literature (Hermans 2021) as being different from the above types are "learning platforms" which bring participants together to share their insights over time and thus facilitate learning among the participants. This is enabled by the synergy of participants working together and realize the potential in growing their knowledge and improving their performance. These could be educational platforms or other kinds of platforms

such as open-source platforms. All are enabled by the digital environment that is advancing day by day.

How do platforms become successful? If the platform can create of an entry barrier to prevent other platforms to muscle in to the same market, then the platforms can be successful. By the same token, establishing such entry barriers are not always easy, which is one reason platform businesses fail. It is also necessary to sustain the value created for participants over time. The governance structure, rules and protocols also play an important role in the success of the platforms. Over time the platforms also become indispensable for the participants, and this allows the platforms to extract value from the participants. For example, Amazon as a platform can increase the commission on the sales made by the smaller retailers on its platform. They can force the retailers to advertise and bid for keywords on their platform. Similarly, platforms such iPhone and Android have control on the specific apps that could be featured on their platforms and the specific commission they could charge on the revenue the apps make on their platforms. Smaller retailers and apps with insignificant brand awareness do not any option other than to stay on the platforms. Platforms, therefore, can easily become monopolies with the control they have on the marketplaces they create. For the retailers, the only way to fight back the commoditization of the product categories by the platforms is to build their own brands and use alternate channels to reach the market. Hagiu and Wright (2021) outline strategies that retailers and firms can take to counter the power of the platforms. Reinartz et al (2019) show how retailers can adopt a platform model to compete in a crowded retail market and transform the value chain.

Metaverse

The latest development in platforms is the concept of metaverse, where virtual reality technology is used to immerse users in a virtual "meta" world. While the entry to the platform is through VR technology, the virtual world is also populated by other users through their avatars. Users can interact with other users like in a social media platform, exchange messages and content, form groups and communities focused on specific interests, all the while the platform owner can target the users with advertisement and messages from businesses. In addition, businesses can open storefronts in the metaverse (much like in Taobao or in a physical mall) and users can visit and make purchases. Different platforms can be created by owners in the metaverse, but these walled gardens could also be connected so that users can migrate from one meta world to another. Metaverse is the virtual counterpart of the real world – so employees within an organization can have meetings at the virtual location of the firm in a virtual conference room with users' avatars sitting in their chairs around the table. At the end of the meeting, Users can check out and do shopping or hangout with friends. The stores will be able to provide 3-D representation of the items they sell and a user can get close to the item and view the details in 3-D. Users can attend live music shows (Stern 2021). Metaverse will enable the morphing of all types of platforms that we have discussed so far – social media, e-commerce platforms, search engines – and there is already intense competition among firms such as Meta (Facebook) and Microsoft to stake their claim in the virtual world.

Models based on Product and Content

The concept of product is undergoing a rapid transformation in the digital age. The augmentation of the core product with services is becoming increasingly digital, where the core value of the product is increased with value derived from digital enhancements. For example, automobiles with GPS systems, sensor-based self-driving technologies, self-monitoring and automatic ordering refrigerators, are basically traditional products that have been infused with digital services to make them more than product – they morph into servicitized products with increased value proposition for customers (Vargo 2017). In addition, the digitization of the products allow them to be networked with connectivity.

This has important implications for new business models. First, the networking of products using online and mobile technologies is spawning a rental economy wherein the dormant value of owned-products is released through digital networking for rental options (e.g., Airbnb for houses and Uber for automobiles). Such products enable the platform models that we discussed in the previous section. Second, the products themselves become the entry for providing value enhancing services. For example, developments in Internet of Things (IoT), where products are infused with smart technologies enable communication with each other and the users and allow services to be provided to users on a continual basis. Another recent example is that of Peloton, which uses the product and connectivity to provide work-out services for customers at their homes. Third, products/services themselves are morphing into services, especially in the domain of information products such as software, and content such as music, video and text, with online and mobile technologies playing a key role in delivery and fulfillment. This has provided opportunities to create product lines of various digital and traditional non- digital formats with interesting implications for bundling models.

The digital environment has also led to the rise of Direct-to-Consumer (DTC) models with Blue Apron, Hello Fresh, Dollar-Shave-Club being good examples of the non-digital

category. In the digital category, content – whether it is entertainment content, software or other kinds of information products – have led to the emergence of ad-supported content models (especially for news and other content), one of the most common form of digital business models. All these developments also provide opportunities for customizing and personalizing content/product and service offerings, by varying not only the core product/service but also the augmented digital services. As new technologies come into play, this whole process becomes a continuous and dynamic one, just Augmented Reality and Virtual Reality are transforming how retailing and home-gym services are delivered.

The digitization of products and content also allow new forms of pricing models such as freemium and direct-to-consumer subscription models. We will focus on these next.

Freemium Models

For firms selling content or a digital service online, it can be a challenge to acquire new customers. Potential customers may not know the features of the content or service or have the experience of using the content/service. For many such experience goods, their quality can be determined only after using or experiencing those goods. In such contexts, many firms contemplate using a freemium or a free trial model to acquire customers.

The "freemium" model is basically a product line of free version and a premium version. It is a pricing strategy by which a product or service is provided free of charge, then an enhanced version of service is offered for a price. A free trial on the other hand offers the priced full service for free for a limited amount of time so that customers can try the service and experience it. Examples include Hulu streaming service available for free for a period of 3 months or Netflix offering a free trial for a month. While the free version in a freemium is a lower-tier service with fewer functionality, the free trial model usually includes all features in the service/product for free but for a limited time. There could also be an in-between model like what NYTimes.com offers – one can read 20 free articles per month, but if one needs more articles within a month they have to sign up by paying. The 20 twenty free articles could be anything and not limited to certain topics, but the quantity is limited. Popular examples of the freemium include Spotify, which has an ad-supported free service and a premium version with no ads and HootSuite, a popular social media management tool, offers free plans for individuals who want to manage up to three social profiles, and business plans for those who need more. HootSuite's freemium approach is to allow users to get to know the benefits of using their platform with enough access to their main features to know that they want access to more. Their approach works because most social media users, even individuals, will have more than three social media profiles to manage. LinkedIn and Skype are other examples.

Freemium model helps to build brand awareness and provide a costless way for customers to sample and experience a new product or service. Free features are a potent marketing tool, which allows a firm to scale up and attract a user base without expending resources on costly ad campaigns or a traditional sales force. Finally, social networks and associated word-of-mouth are powerful drivers. Many services offer incentives for referring friends, which is more appealing when the product is free. The main objective is, of course, to convert free customers to paying customers. This assumes that there are customers who value using the service enough that they are willing to pay for additional or different functionality and willing to purchase the premium version in the presence of the free version.

If a company is unable to convert an adequate fraction of its free customers to paying customers, the freemium model is likely to fail. Some firms like Spotify monetize free customers through advertising. This can recoup some of the costs of providing free service. Mobile games monetize by selling add-on features like in-app purchases which can support such a model. The conversion rate (from free to premium upgrades) for most firms range between 2 – 5 percent. Spotify is an exception with 27%, but for other firms

it is much lower. While a very low conversion rate can be bad, which may indicate that the premium version does not have much added value or the firm could be giving away too much value for free, a very high conversion rate may not be all positive, because it may indicate that the free offering is not attracting as much viral attention (Kumar 2014). In the long-term, the best strategy is something that will attract a high volume of traffic and a moderate rate of conversion.

When should freemium models be used? The most important aspect is that marginal cost of an additional user should be very low, ideally zero like in digital goods – like an extra copy of an e-book or movie. There has to be a significant differential between what is given for free and what is premium. The free option should be attractive enough to attract free users and the premium version should have enough additional value for users to upgrade. The premium version should also be priced appropriately – not too high for the additional value it provides. A firm can differentiate between the free option and premium option on many dimensions of features as well as usage and user characteristics. For example, free version could have a significant delay in response time which might be acceptable for a patient user but not for impatient user, who may want to upgrade to the premium with faster speed.

While firms have the option to use freemium or free trial models, the important question remains when they should go for free trial instead of freemium. If all features of the product/service need to be experienced to understand the value proposition of the premium offering, then the firm needs to offer free trial for a limited time with all features of the offering. Also, if providing free offering is costly over time, then free trial is a good option. The online environment provides easy options to experiment with the freemium and free trial models. Li, Jain and Kannan (2019) show that free versions of free trials should be designed in a specific way to increase the sales of the premium version/ or the version that is being marketed. Thus, specific design of these offerings play an important role in the success of the freemium/free trial models. Gu, Kannan and Ma (2018) show that freemium models can benefit from having a product line of premium products – that is, in addition to the free version, the firm should have at least two premium versions. They show that by appropriately pricing these premium lines, firms can activate either compromise effect or attraction effect which lead to increased sales of the premium versions, moving customers away from the free version. Finally, there have been instances where firms have moved away from the freemium model once they have acquired enough customers. Similarly, since the concept streaming has become well-known, many streaming services do not offer free trials anymore but provide customers to cancel their services at any time.

Subscription Models

With the popularity of direct-to-consumer (DTC) models, subscription pricing models have also become very popular. One of the advantages of the subscription pricing model is that payment is recurring and automatic and is useful to measure retention of the customers easily. Strictly speaking, subscription models by themselves do not increase retention, but since subscriptions are form of a contractual relationship, it is easy to identify how many customers you have and how many have churned as compared to a non-contractual setting. From that viewpoint, it helps to highlight the churn problems that you might be having and take corrective action to retain customers. More formally, subscription model is a pricing model where customer pays a regularly recurring amount in exchange for the use a product or service. Examples include streaming (Amazon Prime, Netflix), online news and content (WSJ.com , NYTimes.com), products shipped on a regular basis (Dollar Shave Club, Hello Fresh, etc.).

A well-implemented and well-run subscription model can have high retention rates. Firms can be quite selective in acquiring customers for subscription model by highlighting the continuing value of the business to the customers. Acquisition of customers is also forced to be more customer lifetime value-oriented and more towards acquiring the right customers with higher retention rates. Freemium or free trial models may help in such acquisition efforts. An added advantage of the subscription models is that investors and analysts love the model because of predictable revenue stream given the retention rates.

There are many factors that help retention in subscription models. One is easy payments using auto-pay services and auto-renewals, so that customers' credit card gets charged automatically. Sometimes customers do not come around to cancelling subscriptions due to pure inertia. Other times even when they want to cancel subscriptions, the firms make it very difficult for customers to cancel easily – information for cancelling the service is not easily accessible on the website or customers may have to call the call-center to cancel. Then there is the sunk cost effect. That is, customers feel compelled to shop – because not doing so would be "wasting" the money they have already paid for the subscription Finally, there is the endowment effect. Once a consumer has access to and is receiving curated products, or can enjoy the convenience of replenishment, they are less likely to want to give those up.

In addition to the above, there are several other factors that impact retention in a subscription model. First, there is social influence – positive word of mouth within social

networks and among members can have a positive impact on ongoing relationship and retention. Second, usage plays a critical role in subscription renewal – usage facilitates customers to derive the value from the product/service - this is one reason that Peloton would want its customers to exercise regularly and send customers nudges for it. If they do not exercise, then they would see the subscription as a waste and cancel it. Third, there are opportunities for learning customer preferences in the ongoing relationship. This can help in product/service personalization and thereby focus on increasing value for customers, which has a positive impact on retention.

Subscription models have become so popular that they are being over-used by firms and are getting a backlash in recent times. First, they are overused as a locking mechanism. As this comment from Scott Stein of CNET highlights, "Suddenly, or more than ever, we're subscribing to everything…We rent the world we live in." This, of course, makes customers waste a lot of money on things they really do not need or use on a regular basis. Firms making it difficult to cancel subscriptions leads to customer ire and negative word of mouth. This has also attracted the attention of regulators. Finally, from the firms' viewpoint, subscription implementation can lead to increased costs in the interim till, if and when, the model stabilizes. Despite all these negatives, if a subscription model is conceived and designed well to provide value to both customers and the firms, it can contribute to the firm's value significantly. Amazon Prime is a good example and there are many such examples.

Conclusion

As digital technologies advance along with developments in artificial intelligence technologies, there are many opportunities for firms to find niches in the business landscape where they can differentiate themselves in creating value for customers. A good example is the online retailing industry, where personalization technologies are providing website of personalized website offerings for each customer using AI technologies, so that customers do not have to endlessly search for the products they prefer. Companies such as Stitch Fix and The Yes are pioneers in such business models. The next frontier of digital business model lies at the confluence of emerging digital technologies and AI and machine learning techniques. The business models will also likely have a shorter life span as pace of development increases. We are indeed living in exciting times!

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#3

Employee and Team Digital Readiness

How to Get Employees and Teams Ready for Digital Transformation?

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While human capital is crucial to digital transformation, little is known about employee digital readiness, and how this may foster digital transformation.
This chapter conceptualizes employee digital readiness and postulates its drivers and consequences.
Based on a literature review, we highlight two distinct patterns that promote psychological and behavioral outcomes of digital readiness. The psychological pattern suggest that firms can reduce technological anxiety by providing organizational support that enhance employee's capability. The behavioral pattern shows that in order to improve effective use, firms should enhance collegial support and enhance the appropriateness of digital tools, which will increase the usefulness of digital transformation.
Finally, we introduce a team perspective and conceptualize how employee digital readiness affects outcomes by relating the focal member's digital readiness to the team's digital readiness. We hypothesize possible psychological and behavioral outcomes based on whether the focal employee and team have high or low readiness, and suggest remedies in case of (mis)fit situations.

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The Idea in brief

The Issue	The Response	The Bottom Line
Digital transformation is not about technology, but about people, and, in particular, based on their ability to use digital technologies. Employee digital readiness is crucial to successful digital transformation. Yet, little is known about employee digital readiness.	Using the employee-team -fit literature, we develop a psychological and behavioral input-output framework of employee and team digital readiness.	The framework identifies the drivers and consequences of employee digital readiness. Managers can devise appropriate response strategies to foster employee and team digital readiness and shape the success of digital transformation.

Introduction

"Digital transformation is not about technology; it is about people"
Tabrizi, Lam, Girard, & Irvin (2019)

"Digital transformation is about talent, not technology"
Frankiewicz & Chamorro-Premuzic (2020)

"Digital transformation is not only about technology but requires a focus on employee factors, alongside shifts in organizational strategy, structures, and processes"
Trenerry, Chng, Wang, Suhaila, Lim, Lu, & Oh (2021)

The statements above emphasize that Digital Transformation (DT) goes beyond technology. Technology provides possibilities for efficiency gains and greater customer value. Particularly, digital innovations enable the transformation of customer experiences, operational processes, and, ultimately, a company's business model (Westerman et al. 2015). Yet, the enabling part is made possible by employees. When they "lack the right mindset to change and [when] the current organizational practices are flawed, DT will simply magnify those flaws" (Tabrizi et al. 2019).

Rather than relying on external expertise provided by expensive consultants, who tend to apply one- size-fits-all solutions in the name of "best practices", Tabrizi and colleagues suggest capitalizing on the organization's human capital. Current employees have intimate knowledge about the primary processes in their daily operations, and their knowledge can be leveraged to foster creative solutions. To a large extent, employees' ability to generate creative ideas (by combining business knowledge with technology) and engage in digital transformation initiatives depends on their digital readiness. In other words, employees' beliefs about technological change are likely to influence their engagement in, or withdrawal from, their company's digital transformation initiatives, and, which, in turn, determine behavioral outcomes (Solberg et al. 2020).

Relatively little is known about employees' digital readiness (Gfrerer et al. 2021), its drivers, and consequences. To better understand the concept, we introduce a framework that introduces the drivers of digital readiness, the components of digital readiness, and the positive and negative consequences that result from a higher level of digital readiness. We hypothesize two distinct patterns in how to promote two psychological and behavioral outcomes of digital readiness. We delineate how managers can apply and, for instance, reduce technological anxiety and enhance employee's capability via the provision of organizational support. Furthermore, we show that managers should pay attention to the digital readiness of the employee's digital readiness relative to his/her team members to account for matching and unmatching (i.e. different) levels between employees and their teams' digital readiness.

Employee digital readiness

We define employee digital readiness as the employee's willingness and ability to engage in digital transformation. Digital transformation refers to the development of new business models that make use of digital technologies (Verhoef et al. 2021; Wessel et al. 2020). Digital transformation initiatives require a major change effort, as employees need to familiarize with and deploy (complex) digital technologies to reconfigure the business logic of a firm. Hence, digital transformation will have a persistent effect on how employees perform their daily tasks. Research shows that employees resist change because they experience fear and discomfort when they have to adapt to new practices (Oreg 2006; Oreg and Sverdlik 2011; Rafferty and Jimmieson 2017). Information system research augments this by arguing that employees resist technologies because of the perceived incapability and threat to lose control of their work (Bhattacherjee and Hikmet 2007). Hence, fostering this digital readiness, in which individuals are willing to and capable of using such technologies, is key to successful digital transformation.

We consider the concept of employee digital readiness has an attitudinal and behavioral component. The degree to which employees are ready depends on employees perceived use benefits (attitude) and actual use (behavior). First, employees who are convinced of the benefits of digital technologies to their daily work, are more prone to engage in digital transformation through their greater appreciation of the benefits; a term we call digital valence. Commonly identified benefits of using technologies are increased productivity via efficient data access and management, optimization of tedious tasks, enhanced knowledge sharing, and collaboration as well as better understanding of customers' needs. Second, employees who possess knowledge and skills to use technologies to support their work are more digitally ready through their greater efficacy of using technologies. We coin this term digital efficacy. Thus, we argue that digital valence and digital efficacy constitute employee digital readiness.

In our framework (see Figure 1), we consider that individual input (employee's socio-demographic traits and personality) and organizational input (organizational strategy, structure and (team) processes) variables to influence digital readiness. Furthermore, we argue that improvements in digital readiness lead to different psychological (job fulfilment, commitment, technostress, and alienation) and behavioral outcomes (productivity enhancements, organizational citizenship behaviors, absenteeism).

Table 1. Definitions, consequences and outcomes of digital readiness

Concept	Definition
Employee digital readiness	An employee's willingness and ability to engage in digital transformatio.n
- Digital valence	An employee's belief that digital technology use has intrinsic and extrinsic benefits.
- Digital valence	An employee's ability to use digital technologies to produce desired or intended results.
Drivers of employee digital readiness	
- Individual input	Individual drivers or triggers of digital readiness such as sociodemographics (gender, age, education) and personality.
- Organizational input	Organizational drivers or triggers of digital readiness such as organizational strategy, structures, and (team) processes.
Consequences of employee digital readiness	
- Psychological output	Psychological outcomes of digital readiness such as job fulfilment commitment, technostress and alienation.
- Behavioral output	Behavioral outcomes of digital readiness, such as effective use of technologies, work performance and productivity enhance-ments, compliance and organizational citizenship behaviors, as well as counterproductive behaviors like cyber-deviance, online bullying and absenteeism.

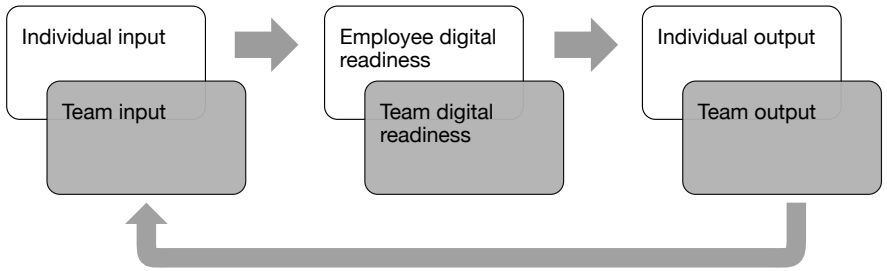

Figure 1: Employee and team digital readiness map

Drivers of employee digital readiness

Individual input to digital readiness

We conceptualize employee digital readiness to be composed of an attitudinal (digital valence) and a behavioral component (digital efficacy). Differences in individual input and/or organizational input variables serve as input to the employee's digital readiness. We will first focus on reviewing the individual inputs. Concerning digital valence and digital efficacy, age has been found to predict employees' perception about technology interruptions (Caldwell et al. 2004; Tams et al. 2018). Seniors tend to score lower on digital readiness as they are more sensitive to the interruption of technologies and have fewer mental resources and computer experience compared to younger people (Tams et al. 2018).

Personality traits may determine employees' mental state related to digital readiness. For instance, research examining the big five personality traits shows that neuroticism (i.e., the tendency to experience negative affect such as anger, anxiety and emotional instability) enhances stressful encounters with new technologies and lowers digital valence, while conscientiousness (i.e., the tendency to carry out one's work well and thoroughly) and openness (i.e., the tendency to be eager to learn and experience new things) do otherwise (Caldwell and Liu 2011; Devaraj et al. 2008; Maier et al. 2019; Srivastava et al. 2015). Extraversion (i.e., the tendency to get energized in the company of others), and agreeableness, (i.e., the tendency to easily show trust, altruism, kindness and affection), may lead to higher perceptions of digital usefulness, especially when other colleagues or direct supervisors have the same perception about digital technologies (Devaraj et al. 2008).

Other technologically specific personality dispositions such as personal innovativeness with IT (i.e., willingness of an individual to try out any new information technology), and information technology mindfulness (e.g., the tendency where the user focuses on the present, pays attention to detail, exhibits a willingness to consider other uses, and expresses genuine interest in investigating IT features and failure) are conducive to employee's level of digital readiness (Maier et al. 2019; Walczuch et al. 2007). Other personality traits like resistance to change inhibits digital readiness (Laumer et al. 2016).

Organizational input to digital readiness

Organizational input factors may foster digital readiness through the creation of a *sense of legitimacy*, such that the digital transformation is based on legitimate reasons (Armenakis et al. 1993; Holt et al. 2010). Employees are more willing to change if they understand and accept the purpose of change. When organizations introduce change, employees will attribute the causes of such change initiatives. This attribution will determine how they will react. Employees interpret change as internally intended or externally driven (Caldwell 2013; Rafferty and Sanders 2018). Results show that employees perceive change as more legitimate when it is thought of as caused by the external environment. For instance, when retail companies rapidly changed their business models to online in response to the Covid-19 pandemic, employees reacted positively because these companies considered their safety, making them more open to such change[1]. Conversely, when organizational change is attributed as internal motives such as cost-cutting or to develop a new strategic goal, employees perceive the change as less legitimate, and are then more resistant to change. Some companies even experienced contempt when attempting to legitimize a massive lay-off to improve firm performance[2]. Applied to the digital transformation context, when firms communicate the process of digital transformation to be externally driven rather than for the organization's best interest, it will more likely convince employees, and contribute to their digital readiness.

Organizational input may also foster employee digital readiness through increasing *appropriateness* – by addressing that digital transformation is an appropriate response to the organization's issues and context (Armenakis et al. 1993; Holt et al. 2010). Rumors may escalate and undermine appropriateness by overstating the negative aspects of change within the organization (Bordia et al. 2004). For example, employees may infer based on unofficial information sources that digital transformation initiatives will make their work progressively less relevant, and ultimately render their jobs superfluous. In other cases, employees can assume that technologies will complicate their work by devaluing their current knowledge and experience, such that they are forced to practice and acquire new skills. Targeted communication can effectively tackle this issue by, for instance, highlighting the positive aspects of digital transformation to their work (i.e., greater productivity or more control), or the necessity to change in order to remain competitive in the market. Increased efficiency and accuracy are obvious benefits of technologies to their work. Furthermore, technologies may also increase flexibility by allowing employees to work remotely, and actively steer their work-life balance. Managers should also ensure that the organization will support its employees beyond providing knowledge. As an example, reducing performance goals or assigning flexible goals during time of change may alleviate the stress of maintaining work performance and set the stage for employees to embrace digital transformation (Polites and Karahanna

1 https://home.kpmg/xx/en/home/insights/2020/03/realities-of-retailing-in-covid-19-world.html

2 https://fortune.com/2012/02/13/pepsis-ceo-faces-her-biggest-challenge/

2013; Stoddard and Jarvenpaa 1995). Flexible goals evaluate employees in terms of the processes (e.g., how employees improve their technological skills and apply new technologies to their work) rather than the result (e.g., how employees primarily perform at work). Consequently, employees will have sufficient time to learn and experience new technologies, which eventually contribute to an increase in their efficacy (through learning) and valence (through exposure to digital technologies).

Finally, organizational inputs can increase employee digital readiness by providing sufficient *organizational support*. This support can address the lack of readiness through nurturing the perceived usefulness of technologies (digital valence) or through helping employees build and improve new skills (digital efficacy). For instance, training is a common HR practice to increase employee support for digital transformation (Eby et al. 2000). Research shows that training programs can be more effective when they consider real-world context and relate closely to employees' daily tasks (Polites and Karahanna 2013). Besides providing key knowledge and increase efficacy, this type of training also increases employees' awareness of the possibilities offered by new digital technologies, which may encourage them to apply technologies to daily works to increase efficiency.

Consequences of employee digital readiness

Compared with the drivers of employee digital readiness, much less is known on its consequences: the output of digital readiness. Scholars assume that readiness leads to positive psychological consequences. For instance, Rafferty and Minbashian (2018) show that employees are not only more compliant to, but also more supportive of (technological) changes. Conversely, unready employees tend to experience more stress as they have to spend much more personal resources to adapt to new changes as well as perceiving insecurity and may result in a lack of psychological safety. Digitally ready employees tend to support the process of digital transformation and function effectively with new technologies. These employees often perceive technologies as more useful and easier to use and to apply to their work (Kwahk and Lee 2008). Thanks to their supportive attitude, employees will be less prone to technostress – stressful conditions created by using new technologies (Ragu-Nathan et al. 2008). Technostress, like any other type of work stress, is positively associated with burnout, psychological strains, turnover, to name a few (Tarafdar et al. 2019). Moreover, digital ready employees tend to demonstrate positive behavioral responses, ranging from effective use of digital technologies, increased performance to peer support, and other extra-role (organizational citizenship) behaviors. When employees are able to improve their digital output via greater digital readiness, this may provide positive attitudinal and behavioral outcomes that feedback as input to an employee's future readiness (see redirected arrow in Figure 1). Because of the considerable benefits of fostering employees' digital readiness, managers should pay attention to improving digital readiness to ensure the success and avoid negative side effects of digital transformation. Particular suggestions are discussed below.

1. Team perspective to digital readiness

While ensuring high employee digital readiness is one of the key issues for firms engaging in digital transformation, it is of equal importance to notice the interpersonal aspect of digital readiness. To put it differently, the digital readiness of employees corresponds to and is influenced by the digital readiness of their team and/or their supervisor. From research, we know that a misfit in digital readiness – a situation whereby a particular employee and his or her team or supervisor having diverse levels of digital readiness – can be as detrimental to team productivity, but also harm the employee's performance and wellbeing.

The person-environmental fit theory introduces an interpersonal perspective to digital readiness and suggests that people attempt to fit with the environment because they prefer consistency and control over their life as well as identification and sense of belonging (Kristof-Brown et al. 2005). Interpersonal digital readiness refers to the

compatibility of the digital readiness of a particular employee relative to one's team members. Existing approach assesses team digital readiness by taking a composite (the average) of employee digital readiness to represent the digital readiness stock of all its members.

Putting together employee and team digital readiness, we show four possible conditions of the digital readiness fit/misfit: Fit conditions in which the digital readiness levels of an employee and team/supervisor are similar and highly overlapping (Quadrant A and D), and misfit conditions in which there is a significant difference between the employee and the team/supervisor concerning digital readiness (Quadrant B and C). Each quadrant has potential benefits and/or problems necessitating different strategies for increasing employees' digital readiness. We will explain them below.

Table 1: Possible conditions of employee and team digital readiness

		Team digital readiness	
		High	Low
Employee digital readiness	High	**(A) Ready for digital!** High fit, high readiness *Positive* psychological output *Positive* behavioral output	**(B) Digital Alone!** Surplus relative to team *Negative* psychological output *Negative* behavioral output
	Low	**(C) Digital? Count me out!** Deficiency relative to team *Negative* psychological output *Positive* and *negative* behavioral output	**(D) Digital? Not with us!** High fit, low readiness *Positive* psychological output *Negative* behavioral output

Ready for digital! (Quadrant A)

Quadrant A is characterized by high employee and team digital readiness, which is the most positive condition in table 1. High team and supervisor digital readiness means that the focal employee and team members are capable and effectively use technologies. The team climate will be supportive of adopting, experimenting, implementing and using new technologies to effectively and efficiently solve daily work. Thanks to a positive attitude of the supervisor, financial support can also be sufficiently provided to overcome innovation barriers and quickly react to the internalization of new technologies (Gfrerer et al. 2021). Working in such a digitally savvy team, digitally ready employees can put their digital skills to best use. In addition, there will be mutual understanding, better exchange with peers and supervisors (Marstand et al. 2017; Matta et al. 2015; Shin et al. 2017) as well as higher identification and team commitment. Stressful conditions due to misfit are less likely to occur for focal employees. The psychological output of lower stress and behavioral output of effective use will jointly lead to improved team and individual performance.

Digital Alone! (Quadrant B)

Quadrant B is a situation where the focal employee has a high digital readiness but that of one's team is low. We term this condition digital readiness surplus. A downside to low team digital readiness, as described above, is the lack of a digitally supportive climate and support from the supervisors and peers. While adding a digitally ready employee to a low team digital readiness makes intuitive sense to foster team digital readiness, such digital savvy employees may themselves experience problems and conflicts because of the dissimilarity with his or her boss and peers. Such discrepancies will reduce the identification with and the commitment to the team, as the person-environment fit theory shows. Furthermore, stress is a potential problem for these employees. They might have to handle digital work in place of their peers and be frequently asked for advice, creating work overload.

Another theoretical viewpoint of attraction-selection-attrition – namely the process whereby similar employees are chosen to a workplace – predicts that turnover is inevitable for these digitally ready employees (Wu and Chi 2020). Furthermore, through disappointment in the employment situation, these employees might engage in counterproductive behaviors – actions intended to have detrimental effects on the organization and its members (Liu et al. 2015). Counterproductive behaviors may include workplace aggression as the employee perceived him or herself better than their peers or the boss. Teams that lack digital readiness might find it hard to detect fraudulent behaviors done by digitally ready employees. Although these examples are extreme, digital readiness surplus is shown in research to be harmful to employee psychological well-being. Employee's effective use of technology is also hindered by the team climate because of distraction and work overload.

Digital? Count me out! (Quadrant C)

Similar to the other misfit condition (Quadrant B), digital readiness deficiency prevents employees to identify with and be committed to the team. A high level of stress is likely to result, as focal employees have to deal with tech technologies supported and internalized by their supervisors and peers. Focal employees, who are disadvantaged relative to their team members in terms of digital readiness, are more likely to experience insecurity as they fear that they are not highly valued and can be replaced any time with the team.

Further, the complexity and uncertainty that result from new technologies cause a major hindrance at work (Tarafdar et al. 2019).

While ample opportunities exist for the digitally unready employees to improve and thrive through taking advantage of their digitally ready environment and through continued exposure and peer learning, the employee must be motivated and supported to tackle the psychological stress. Attraction-selection- attrition theory suggests that negative consequences occur including burnout, fatigue, absenteeism that may foster employee churn and increase team employee turnover.

Digital? Not with us! (Quadrant D)

Quadrant D describes a condition whereby employee and team digital readiness is low. While low team digital readiness nurtures a culture that does not support the use of technologies, employees in this condition will experience low stress as they are fit within their team (Edwards and Rothbard 1999; Yang et al. 2008). The high fit between team members suggests that team identification and team commitment will be high (Greguras and Diefendorff 2009; Li et al. 2019). On the other hand, because the employee and the team lack the perception of technological usefulness and the skills to use those technologies, effective use of technologies will not be (easily) realized. Such an apathetic team climate will not be beneficial for the firm's attempts to digital transformation.

Fostering digital readiness at the employee and team level

To foster digital readiness at the employee and team level, we will provide some managerial implications.

i. **Appoint champions:** Relying on the individual input of digital readiness, managers will be able to select the most suitable employees as change agents and leading examples to promote digital transformation. Digitally ready employees may promote and instigate change – especially when they have positive characteristics such as extraversion, innovativeness, and optimism. Choosing the right change agent will foster the other's employee and team digital readiness to achieve the high fit conditions.

ii. **Communication is king:** Communication the purpose of digital transformation to employees reduces the negative attribution process and increases the perceived legitimacy and appropriateness of digital transformation, which in turn foster employee digital readiness. Research shows that when employees attribute the cause of change as external or as beneficial to themselves (Rafferty and Sanders 2018), they perceive the change as more legitimate and appropriate. Thus, internal communication should be carefully drafted and implemented. For instance, managers should demonstrate the direct benefits of using new technologies to employees' daily tasks, such that they will be convinced that their effort to change is worthwhile and pays off in the near future. Our suggestion does not imply that managers should be overly optimistic and consistently communicate the benefits of digital transformation to employees. In practice, digital technologies are also implemented to remain competitive without producing any direct employee benefits; for instance, by cutting costs via laying off employees or by pursuing new strategic initiatives. Employees may sense when managers are dishonest, which should be avoided to leadership and communication (Cartwright and Holmes 2006).

iii. **Organize change with sufficient organizational support:** Managers can adjust performance goals to facilitate technology adoption and continued use. A strong process-oriented focus will help employees to familiarize themselves with new technological applications. Result-oriented indicators should be relaxed such that employees can have the time available to master the technologies. Further, digital training is another important issue. Managers should ensure that the digital training program is not "too theoretical" and covers practical aspects of the new technologies. In other words, after the training, employees must understand the benefits of technologies to their work and be able to use technologies in their daily work. Finally, promoting peer support by allowing more digitally ready employees to encourage and guide others is an effective strategy to improve the team's digital readiness and create a high fit condition.

iv. **Support digital experts in low readiness teams:** Digitally ready employees should be identified and supported such that they are able to put their skills to good use. Managers should secure sufficient time, for instance by removing some of their daily routine tasks, such that they can spend time to educate, motivate and guide their peers, especially regarding the use of digital technologies. If the employee considers oneself to be overqualified for the team, this attitude might not be healthy for the work environment. They should communicate clearly and act empathically so that they appear friendly and supportive to others. Personality plays a role here. If the employee's personality does not fit to be a guide and a "digital evangelist", moving his or her to another digitally ready team might be the best possible solution. Another way to improve the influence of digital experts is to expand their internal networks and focus on letting them taking a central role; the more central these experts become, the more impact this will have on the diffusion of knowledge and the attitudes and behaviors of peers.

v. **Help digital novices to catch up in high digital readiness teams:** Managers should pay close attention to and support employees with a deficiency relative to their team members. Such employees feel that they are falling behind, and may experience incompetence and disdain from their direct colleagues. To reconnect digital novices to high-digital ready teams, managers should take corrective action when such negative signals appear to avoid negative attitudinal and behavioral spirals. To prevent such negative spirals, managers should develop an inclusive environment to motivate and engage them. Team leaders could use different tactics such as training provision, peer support, and peer mentoring to improve the digital readiness of novices.

vi. **Resolve the high fit, low digital readiness condition:** Managers face a challenging situation when all members have low levels of digital readiness, and increase the input and output variables of it. A strategy to deal with the low fit condition is to introduce tech-savvy team leaders (either newly hired or from other organizational teams), whose power and influence can later be used to promote the team's digital readiness. After fostering the digital climate, firms should recruit digitally ready employees to pioneer and provide support digital transformation. It is important that organizational support is geared towards stimulating the entire team's level of digital readiness. Training programs for such teams are recommended as they may collectively lift the technological abilities and create shared positive attitudes towards the use of digital technologies.

Conclusion

Companies can foster digital transformation through leveraging the human capital. In this chapter, we stress the importance of employees' digital readiness, *the employee's willingness and ability to engage in digital transformation*. While companies need to navigate in the age of abundant technology, the employees' willingness and ability to use these technologies will determine the organization's ultimate successful transformation. This chapter shows that while implementing technologies might come from a good intention, failure to manage the technological changes cause adverse effects to employees. Instead, managers should consider the digital readiness of individual employees operating in teams, and how to maximize the returns on its human capital.

We summarized the existing findings of the literature and conclude that much more research is needed to investigate the input (drivers) and output (consequences) variables of employee digital readiness. Finally, we introduce a team perspective to consider that individual employees do not operate in a vacuum but can learn from and educate their peers. This multilevel perspective increases our understanding of how employee's individual and team digital readiness determine organizational outcomes. While fostering employee and team digital readiness simultaneously is beneficial, we notice that this might not be feasible. We therefore offer solutions on how to deal with the sub-optimal conditions. We hope that our framework and perspective help managers effectively improve employee and team digital readiness.

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#4

Digital Roadmapping

Purpose, Phase and Perspectives

Scan the QR for the animation of this chapter

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Groningen Digital Business Centre (GDBC) - Pubished Novemberl 2021

Developing digital roadmaps help managers to explore and determine the direction of digital transformation for their organizations. The act of developing a systematic digital roadmap fosters an understanding of the purpose of digitalization, how to attain digital skills and resources needed to attain the digital transformation goals, and drives organizational change in a coordinated and effective way. Digital transformation is a risky and uncertain journey, full of unexpected events, where important decisions rely on imperfect information.

Although planning may seem ineffective in such uncertain and highly volatile settings, we argue that digital roadmapping can be an important first step for success. While the desired destination and strategies will differ per firm, carefully developing a roadmap - involving the definition of goals, the exploration of alternative paths, and the implementation and validation of selected digital initiatives - will help organizations to progress in their digital transformation journey in an effective and impactful manner.

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The Idea in brief

The Issue	The Response	The Bottom Line
Digital transformations are risky and complex to manage. Devising a roadmap of the digital transformation journey can help organizations to navigate the uncertain road to success.	After synthesizing a simple step-by-step approach to guide the phases of digital transformation, we introduce four perspectives that help managers to ask the right questions to avoid blind spots and develop a richer understanding of the potential value and risks of digital transformation.	The framework supports an open dialogue with internal and external stakeholders to develop a clear digital goal, and devise a plan to navigate from the present to the future.

Introduction

Roadmaps are used for navigating from point A to B, and help organizations to navigate from the present to the future (Simonse, Hultink, & Buijs, 2015). It describes a detailed plan to guide progress toward the attainment of a goal. Constructing and executing digital transformations can be daunting, and roadmaps offer organizations a way to translate such transformations into manageable parts and activities that help to plan the redeployment and (re)allocation of resources, attain digital skills and tools, and implement digital initiatives to generate value.

This chapter tries to answer the following questions:

- What is digital roadmapping and why do we need it?
- How to develop digital roadmaps, and which steps to follow?
- How to avoid common pitfalls?

Digital roadmaps: What are they and why do we need them?

Digital roadmapping tries to answer the following three questions:

- Where do we stand?
- Where do we want to go?
- How do we get there?

Similar to strategy, digital roadmapping tries to map out and pave the road to get to a preferred point of reference. The activity is a characterized as a design activity, in which managers work collaboratively to exchange and integrate insights from multiple functions and stakeholders for strategy development. This is done with the help of visual tools—sketches, mockups, models, and drawings— and communication tools—brainstorming, Delphi method, and scenario analysis. In this chapter, we assume that organizations want to engage in the pervasive form of digital transformation. In this respect, organizations use digital transformation to introduce a new business model with the help of digital technologies or data. Such an undertaking is highly risky, as it involves a major overhaul of the organization by, for instance, reprogramming of the organization's values and identity, the development of new capabilities, and the introduction of new partnerships, practices, and routines. Furthermore, the development of new business models also involves a major market risk. While new technologies may provide additional product or cost benefits, consumers and markets may not be attracted (yet) by the new value proposition and offering.

A digital roadmap can take along employees in the journey and enable different teams to work on different parts of the transformation while staying aligned. Digital transformation initiatives are useful to empower employees to take initiative, to develop a capability to deploy technologies, and to test whether proposed ideas work and create the intended customer value. A roadmap thus helps to coordinate individual efforts, reduces re-inventing the wheel, and mitigate possible interpersonal coordination conflicts. The existence of a roadmap will help to channel employees' inputs in more constructive ways. Yet, it is important to realize that digital transformation is a highly uncertain process with many unknowns. A roadmap may not fully take away this uncertainty and risk, but should rather be considered as a point of reference that helps to steer the organization in the 'right' direction, and helps to determine what projects and initiatives to undertake; it should not be confused with a detailed blueprint of how to get from point A to point B.

How to develop digital roadmaps, and which steps to follow?

Much has been written on the use of roadmapping for organizational change in the management literature, covering aspects such as the development path of specific technologies (Alcantara & Martens, 2019), how to design and develop specific products (Münch, Trieflinger, & Lang 2019; Al-Ali & Phaal, 2019), and the strategic implications of such developments for the business model of the firm (Phaal, Farrukh, & Probert 2007; Reuver, Bouwman, & Haaker, 2013; Westerman, Bonnet & McAfee, 2014). Roadmapping has also been implemented across a wide range of societal transformations, for example defining organizational objectives and activities in the nano tech revolution (Martin, 2016), enhancing sustainable business practices (Ahmed & Sundaram 2012) and focusing on the transition to renewable energy (Amer & Daim 2010; Daim, Amer, & Brenden, 2012). Additionally, it has been implemented at different organizational scales, from the level of a specific organizational unit (Kim, Beckman, & Agogino, 2018), for the firm itself (Albright & Kappel, 2003), and even for entire global industries (Zheng & Kammen, 2014). Because of this broad implementation of the idea of roadmapping, when managers at an individual firm are faced with the challenge of managing their organization's digital transformation, it is not a simple task to find the appropriate approach and take the appropriate steps. Despite the extensive attention to roadmapping across disciplines, to our knowledge there is no accessible overview to aid organizations in roadmapping their digital transformation. In Figure 1, we synthesize the existing relevant roadmap methodologies into a simple step-by-step approach that individual organizations can easily apply to guide their own digital transformation.

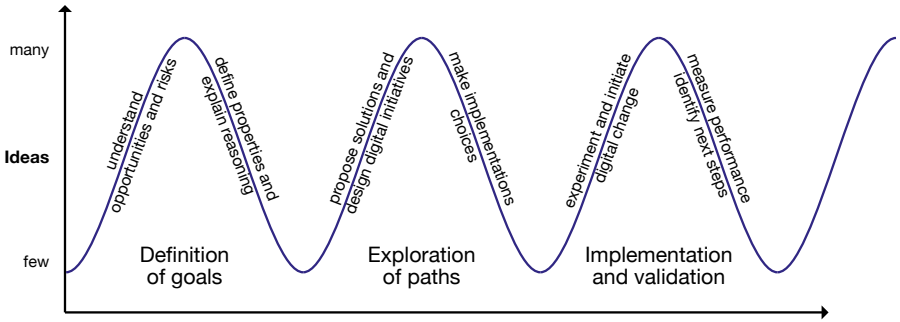


Figure 1: The phases of digital roadmapping

Phase 1: Definition of goals

Understand opportunities and risks: Explore the challenges that the digital economy brings to your organization, both in terms of new possibilities and potential difficulties. Your organization is not the first to undergo a digital transformation and, although each situation is different, there are many lessons to be learned from others' experiences.

Define priorities and explain reasoning: Make choices about the most important goals, in terms of their relevance and impact on your organization, and how achievable they are in practice. Define the timescale within which they may be achieved, preferably in a stepwise, iterative manner. Explain the reasons why these specific goals have been prioritized to help others in your organization align their thinking with the same goals.

Phase 2: Exploration of paths

Propose solutions and design digital initiatives: Creatively explore possible solutions to meet your stated goals, considering the technology, human resources, business processes and possible changes to your products or services.

Make implementation choices: Decide upon the designs and solutions that you will implement in the short term. These sprints are iterative and smaller, achievable implementation choices allow progress to be made without very high investment in time or budget.

Phase 3: Implementation and validation Phase 1: Definition of goals

Experiment and initiate digital change: Now that you have made specific choices, the transformation can be put into practice. By considering the small steps forward to be a form of experimentation, your organization will learn and adapt as you gain experience in digital change. Be realistic and open about what you expect from employees and external partners.

Measure performance and identify next steps: Keeping your stated goals in mind, assess the extent to which the objectives are being met and what needs to be improved in the next iteration. Be aware that the assessment of the performance of your digital transformation could include its impact on your employees, suppliers, customers, finances and on your position in the value chain.

Generally speaking, we can divide roadmapping into three main phases: definition of goals, exploration of paths, and implementation and validation. First, the definition of goals sets out what the organization wants to achieve and develops priorities that will guide different parts of the organization to work towards a unified objective.

This phase also entails coming to a clear understanding of the various pressures, expectations, risks and opportunities that digitalization presents to the organization, and then deciding on a set of SMART (specific, measurable, achievable, relevant and time-dependent) goals.
Second, the exploration of different paths towards the defined goals allows an organization to compare and analyze a wide range of ideas and possibilities. This exploration covers a number of key areas of development within the organization, including human resources, organizational processes, and products or service innovation that may dramatically change what the organization does and the relationships it has with other organizations. Third, the implementation and validation of digitalization initiatives guides the organization towards reaching the defined goals by undertaking activities and changes in an interactive way to maximize their realized impact.

These three phases are not carried out in a simplistic sequential fashion, but should be undertaken in short sprints (Al-Ali & Phaal, 2019). Using sprints in a connected and iterative fashion, organizations can speed up their digitalization capability development as they gain cumulative insights from one sprint to another. It is difficult to prescribe how long a sprint should last, as each digital transformation process is different, but typically the first phase of defining goals could be completed within a week while the third phase of implementation and validation will need longer to achieve. Within each sprint there is first a rapid diversification of ideas and potential choices, followed by a structured convergence towards a single choice based on predefined criteria. This iterative, three-phase approach has the benefit of encouraging progress and enabling decision-making, without requiring immediate large-scale investments or commitments to long-term, uncertain future scenarios. In this sense, it resembles the Agile approach to software development that prioritizes adaptive planning and flexible responses to changes in requirements. McGrath (2010) explains that this lean approach helps managers to deal with the high unpredictability of market responses, and speeds up a firm's learning processes with relatively low risks.
Rather than following a planned approach making huge upfront investments ("large hockey sticks") with unlimited downside risks, organizations should rather develop a discovery approach and make a number of small-scale experiments ("small hockey sticks") to test their specific market assumptions (McGrath, 2010) (see Figure 2).
The potential gains of a single planned approach may seem more attractive to begin with, but experience shows that the accumulation of improvements through the discovery approach is both less risky and more profitable.

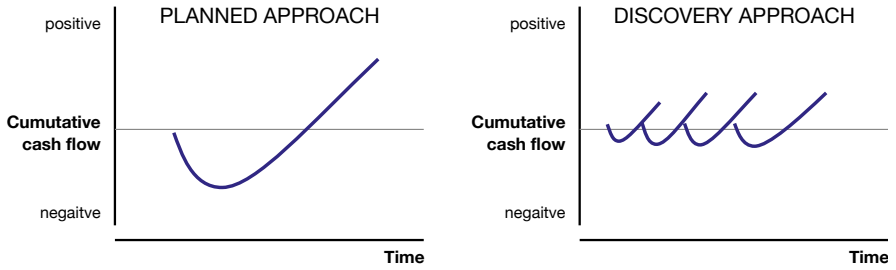


Figure 2: Planned vs. discovery approach (Source: McGrath, 2010)

Phase 1: Definition of goals

In phase 1, the organization adopts an outside-in approach to understand the challenges and opportunities that the digital economy brings to its industry, along with a shared knowledge of how to address digital transformation. Using this understanding, it can then narrow down the set of challenges to define hypotheses and desired outcomes that will serve as a focus and to establish a shared objective within the organization.

Diverging to understand opportunities and risks

This exploratory step helps the organization to understand the changes that digitalization can bring about, and the relevance of these changes for operation. The idea here is to collect information on a wide set of processes, technologies, and organizational implications. The sources of information for this step are extremely diverse, including desk and market research, interviews with experts on digital technology, organizational change, and digital innovation, and creative workshops with employees, customers, or suppliers, who can voice their opinions about the changes happening all around the organization and its industry, brought about by digital transformation. This divergence should be continued as long as the opinions about changes and their implications provide additional insights. If new sources of information only repeat what has already been found, then the point of saturation is reached and the process can move to the next step.

The aim is to build upon notions put forward in order to expand and deepen the organization's overall understanding of what digital transformation implies. At the end of this exploratory, divergent step, the organization should have a long list encompassing the most relevant digital developments, have clarity on how other similar organizations have undergone digital change, and have an explicit list of requirements and expectations of their most important stakeholders, upstream and downstream in the value chain.

As an example, consider a medical center where a small group of general practitioners cares for the health of the local community. The doctors realize that society is undergoing widespread digitalization, and they need to respond by implementing a digital transformation in their medical center. In this first step of the phase of defining their goals, they engage in a series of activities to explore what digitalization could mean for them. They do this by reading up on how other general practitioners have implemented digitalization, discussing new functionality and new technology with IT consultants, as well as liaising with other medical organizations, including their local hospital, physiotherapists and home-care organizations. Additionally, they set up a series of workshops with a selection of their local community in order to gauge the knowledge level and the expectations with respect to digital technology.

Converging to define goals

To rationalize the goals, the organization should prioritize and make choices about what it wants to achieve, and why. The focus in this phase is very much on the organization itself, its strategy, processes, people, and products or services. The synthesis of external developments should lead to the identification and careful description of important objectives so that everybody in the organization has a shared understanding of the objectives and why they have been chosen. At the end of this analytical, convergent step, the organization has a short list of the top priority digitalization goals that can be achieved within a specified timeframe.

In our example of the medical center of general practitioners, the doctors can carry out a number of facilitated workshops where they and their key stakeholders discuss the long list from the divergent step, leading to the prioritization of the two most important goals: offering their clients the ability to share personal health information gathered via devices at home, and providing access to data to other health professionals in the region whilst adhering strictly to privacy regulations. Both of these goals may be iteratively met to differing degrees by smaller steps throughout the planned period of five years. So, for example, the ability for clients to share their personal health information could start in the first month by asking diabetes patients to type in their glucose levels to the center's digital platform, but after a few years it may lead to an integration with a number of proprietary digital systems automatically uploading indicators from blood pressure, through sleep patterns and activity trackers.

Phase 2: Exploration of paths

In the second phase, the organization proposes and sketches a range of digital solutions in order to explore different potential ways of achieving the prioritized goals set out in the previous phase. This creative step makes use of the understanding of opportunities and risks, and then narrows down the selection of digital design initiatives to a shortlist that can be implemented easily.

Diverging to sketch digital solutions and their organizational implications

An organization needs to explore the key areas of development within the organization that are affected by the digital initiatives. Digital transformation may require different organizational qualities and place new demands on human resources, organizational processes, and new products/service development. At the end of this exploratory, divergent step, the organization should have a longlist of digital solutions, including the basic contours of their designs. The exact details on the most appropriate design will be developed in the third phase.

Continuing our example of the medical center of general practitioners, in this step to propose solutions and design digital initiatives the doctors may sketch possible solutions to facilitate the exchange of personal health information using medical devices. Doctors may need to be trained in communicating the benefits to the system and individuals in order to motivate clients to share personal information. Medical devices and data sharing infrastructure that protect the privacy of clients need to be found. Furthermore, changes to organizational systems and supportive staff may need to be designed to facilitate the interaction with clients in a trustworthy and secure way. Finally, an activity can be undertaken to explore solutions that provide feedback to clients, display information in an understandable way, and promote the desired implications for client's treatments or lifestyles.

Converging to make implementation choices for the digital initiatives

To rationalize the exploration of digital solutions and the consequences these may carry for organizations, the relevant managers need to make decisions on which of the designs will best meet the demands of the prioritized objectives, and which will be implementable considering the strategic fit of the new designs with existing products and processes, as well as the likely costs and uncertainties involved. Often, in practice, an organization may choose to link multiple projects in a stepwise manner to attain difficult-to- achieve outcomes in the longer term. In order to do this, they may prepare a sequence of digital projects and specify how they build upon each other. At the end of this analytical, convergent

step, a single digital initiative, or a small set of related initiatives, has been chosen that is both implementable and that meets the defined objectives.

In our example of the medical center of general practitioners, the doctors may select a number of suppliers that offer products that meet the criteria for safe and secure use. A business case may be created on which to base choices about which solutions provide the right benefits within budgetary limitations. Furthermore, to facilitate adoption of such medical devices, implementation choices can be made about how to design the care process including the communication toward the patient, the internal operations, and the reimbursement process with insurers.

Phase 3: Implementation and validation

In this third and final phase, the organization adopts and inside-out approach and experiments with the digital initiative(s) designed in the previous phase. Through rapid experimentation through pilots that foster digital change, it is possible to learn about the viability of the design, adapt implementation where necessary and develop a clear understanding of the impact of the digitalization both within and beyond the organization's boundaries. Using this understanding, it can then narrow down and prioritize the next steps in the process of digital transformation.

Diverging to experiment and initiate digital change

By implementing the small design steps in practice, the digital transformation process can be started. Following the principles of the agile software development process, the small steps may be seen as a form of experimentation and adaptive learning whereby it becomes possible to adapt to progressive insights, quickly adapt the planning and project requirements, and continually enhance the understanding of the problems to be solved. This may lead to the development of new knowledge that can be shared and internalized. At the end of this exploratory, divergent step, the organization should define specific metrics against which the desired outcomes will be measured and how the progress of projects can be monitored.

In our example, small experiments can be carried out in which multiple product solutions or client interfaces are tested. Metrics could capture the experiences of medical staff, clients and suppliers in these experiments, for example by noting the challenges they face or measuring their anxiety. Following this, adjustments can be made to the designs of the implementation choices, and the next design step can provide improvements to reduce or remove this anxiety. These small steps in experimentation and adaptive learning can test different digital solutions, and the assumptions held by their designers, in practice.

In order to be able to identify and monitor whether the digital solutions provide the intended benefits to the internal and external stakeholders, doctors can create a set of metrics. These may include metrics on the early detection of health problems, the degree to which clients experience greater control over their recovery process, and the extent to which they share relevant information in a timely fashion.

Converging to measure performance and identify next steps

In the convergent stage, organizations should assess the degree to which they have attained the desired goals and what needs to be addressed in the next iteration. If progress is below expectations, measures should be initiated to overcome the deficiencies and a frank and open discussion with stakeholders can help the organization to benefit from the insights generated. The cost-benefit analysis needs to include a suitable breadth of indicators relating to all relevant organizational processes and the digital initiative's impact upon various stakeholders and the organization's market position. One main advantage of this validation step, and one main reason for adopting small, achievable steps in an iterative fashion, is that it provides convincing, and realistic, evidence of the benefits of digital transformation. At the end of this analytical, convergent step a well-developed conclusion can be derived that will foster support for the next iteration of the digital transformation process.

To distill learnings from the implementation of digital solutions, and to identify the next steps, the doctors collect and analyze the metrics identified in the previous step so that they can infer the effectiveness of the selected new products or methods compared with those of existing methods. Doctors may not only analyze immediate changes to their clients' information sharing, but also the indirect, long-term benefits and costs of using the new digital approach or method for both clients and for the medical center itself. Additionally, they may partner with health insurance companies to analyze effects on cost efficiency and overall quality adjusted life years. Furthermore, with greater scale and more data, segmentation can be used to determine for which types of clients (age, gender, social status, education, health conditions) a digital solution is most effective, and what additional supportive measures can be used to limit possible disadvantages and negative effects. The knowledge derived from the implementation and validation of digital solutions, whether they are immediately successful or not, can be internalized and applied to other parts of the organization in the subsequent steps in the digital transformation process.

How to avoid common pitfalls? Using four perspectives.

Apart from the sequencing of activities, an organization should also consider what value needs to be created, and how to attain this. In order to avoid common pitfalls and avoid

blind spots, we suggest to use four perspectives to ask the right questions as these perspectives provide a rich and complementary view to increase their understanding of the potential benefits and risks of digital transformation: governance, customer, organization and digital platform. Table 1 explains these perspectives and indicates the key questions that can guide organizations' decision making, foster meaningful conversations with stakeholders, and the development of a well-thought strategy for digital transformation. These should help with the implementation of an effective digital transformation strategy.

Table 1. Four perspectives on digital transformation

Perspective	Focus	Key questions
Governance	The governance of the digital transformation process in terms of actors, responsibilities, incentives and transactions.	What are the key actors within and external to the organization? How can these actors' responsibilities, incentives and transactions be managed to enhance efficiency for the benefit of the organization?
Customer	The way customer value is created through digital transformation.	What does the customer value and want? How can the organization offer the desired products and services in the right manner?
Organization	The act of putting things into a logical order, defining tasks and routines for digital transformation.	How to organize the transition from the present to the future? How to overcome employee resistance? How to resolve employee resistance and ensure employees' digital readiness, such that they embrace and deploy digital tools and technologies?
Digital learning platform	The installment of a platform fostering learning, continuous improvement and innovation.	How to stimulate learning and guarantee the internalization of knowledge? How to ensure continuous improvements, and how to introduce innovations within existing (digital) infrastructures?

Using a governance perspective

The governance perspective informs managers about the actions that must be taken to ensure that the digital transformation is successful. Governance is a broad concept that includes the set of actors, responsibilities, incentives and transactions needed to achieve an organization's goals (Mergel, Edelmann, & Haug, 2019). The principal actors include the shareholders, management, employees, suppliers, customers, regulators, the environment and the community at large. When the organization's governance is well developed, all these stakeholders act in a way that enables the organization to operate efficiently.

The value to the organization of undergoing a digital transformation can be realized in numerous ways and, at the same time, there are equally many challenges to ensure that the governance is optimized through the process of change. Areas of relevance requiring significant attention from the upper management include the organizational processes, the business model, technology implementation, management of the digital transformation initiatives, risk management and potential changes to the governance structure itself (Sambamurthy & Zmud, 2012).

As the digital transformation proceeds, organizations typically undergo a shift in the way that they operate, what they offer to their customers, and the way that they interact with other organizations. These changes will not immediately be understood or accepted by all employees or other stakeholders, particularly for those people who see changes to their roles or responsibilities as being undesirable. Conflict can emerge within the organization, or with suppliers and customers, when the logic of operating in the pre-digital era and the new digital logic need to be aligned (Besharov & Smith, 2014). Before all processes and parts of the organization and its network are aligned, each logic may prescribe actions that are incompatible with the other logic. For the governance to run smoothly, this situation needs to be understood, accepted, and appropriate steps must be taken to quickly align the two perspectives.

In order to align the range of differing opinions and ways of working, a useful approach is to make the incentives impacting on each actor explicit. Incentives may be highly diverse. Employees are, obviously, incentivized by being paid for their work, but there are many other, less obvious incentives at play. These include status, self-determinism, collegiality, societal impact and more. Equally, an organizations suppliers and customers may be incentivized to adopt and work with the digital transformation, or their incentives may encourage them to block progress or fear losing out. Good governance results in all incentives being aligned so that all processes run smoothly, and with internal and external stakeholders feeling fairly remunerated.

Guiding questions:

- Who are the relevant actors within and outside the organization?
- Which dependencies between actors change because of a digital initiative?
- Do these actors commit to the digital transformation and do their responsibilities, incentives and transactions change as a result of digital transformation?
- What are potential negative consequences of digital initiatives for each type of actor?
- Are changes to their incentives possible in order to align their efforts with the new organizational objectives?

Using a customer perspective

Ultimately, customers need to be attracted to the organization's new digital value proposition. A value proposition is the promise made by an organization about how its products or services benefit its customers, in terms of saving them time and effort, improving their situation, or in any other way (Massa, Tucci, & Afuah 2017). Adopting a customer-centric perspective begins by understanding the target customer, what the customer values in terms of what they want to gain and also the difficulties they want to avoid ('pains'), as well as what is feasible for the customer to understand and put into use in practice.

> *As an example, a high school set up a new mobile chat application per mentor class, very typical of many schools, so that parents and teachers could interact easily without the need to organize time-consuming meetings every time an issue arises. The parents, in this example in the role of customers of the school, took enthusiastically to the new application and shared their thoughts and opinions on a wide range of matters. Initially this led to an increase in their perceived value as topics of concern were quickly dealt with. However, after some time, it emerged that certain parents were particularly keen to express their negative opinions and complain about perceived shortcomings on the part of the school. The social atmosphere generated by this negative discussion became a problem for the teachers, particularly as it could quickly become harsh with aggressive tones, who felt they had to react very quickly to prevent problems from escalating. Other parents became influenced by the vociferous minority and the general level of satisfaction declined. Adapting to this, the teachers asked parents to return to making physical appointments to discuss problems, as they noticed that the emotions would calm down after a while and a reasonable discussion would solve almost all problems without bothering other parents. The digital application was then more effective at sharing experiences on less-charged topics.*

There is the danger that managers, who are personally invested in the digital transformation, may be overly positive about the value of their new digital products and business model without being open to see the difficulties that the customers may have with the change, such as switching costs necessary from a non-digital to a digital solution.
In general, there are two ways that a digital initiative creates value for the customer. First, there are sustainable improvements to the customer's current way of operating or product. For example, by speeding up access to information or by automating laborious tasks. Second, there are wholly new functions and possibilities that do not replace earlier products and services but that create completely new forms of value (Christensen, Raynor, & McDonald, 2015). By taking a customer perspective, for example by holding focus groups with representative customers, managers can gain an understanding of their wishes and abilities to accept and adopt the new value proposition, as well as their views on new difficulties arising.

Taking the customer perspective a step further, the development of a digital initiative should start, not with the benefits to the organization, but with defining the new value proposition through focusing on the customers' experience. What do customers themselves think about the change? How quickly can they adapt their understanding of what is possible? What are they worried about in terms of new problems and challenges? Once it becomes clear how to create the most value for the customers, the organization can then adapt its design of the digital initiative to fully meet those needs.

Guiding questions:

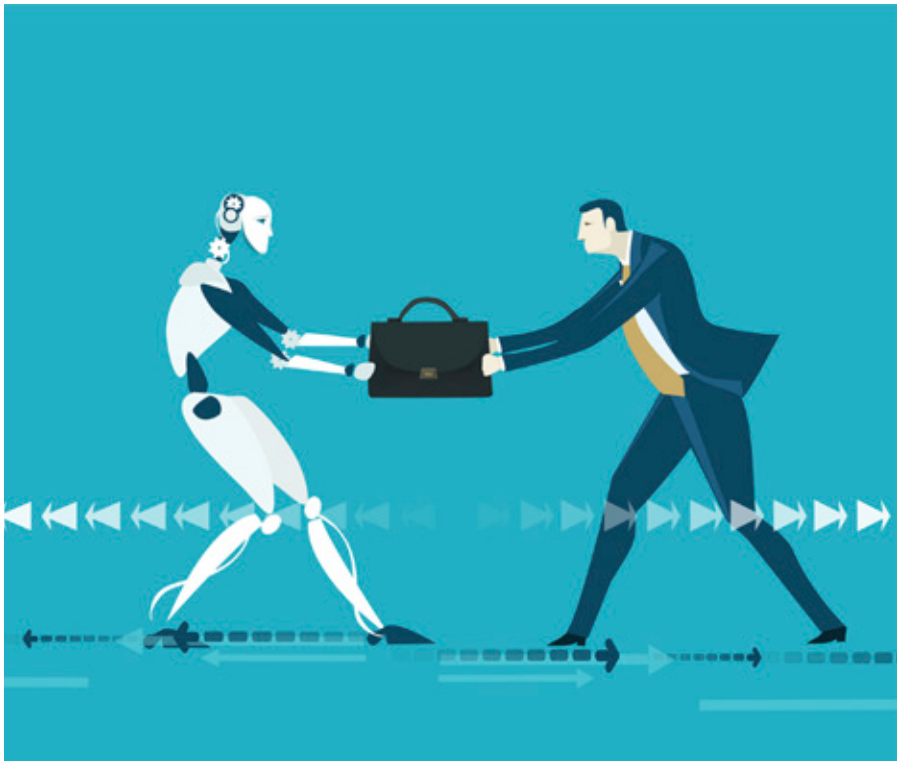
- What value will be created for the customer? What do potential customers say about the new service offering?
- What aspects of the digital initiative do the customers understand, and what aspects do they not (yet) understand? Are customers digitally ready and able to attain digital value?
- Is the new value proposition an incremental change to existing practices or a wholly new form of value?
- What narrative is used to convince customers of the new digital service offering? What possible negative consequences exist for customers, and does the organization truthfully reflect those potential risks?
- Are customers or its representatives (e.g. consumer associations) involved in a panel of advisors throughout the digital transformation process?

Using an organization perspective

The organization perspective informs managers about the activities needed to inform and convince employees in the digital transformation. At the start, a digital team needs to be assembled capable of understanding how value can be created digitally, and what organizational consequences digital transformation bring to the organization.

Research of Libert, Beck, & Wind (2011) hints that effective teams are multidisciplinary and have technological and market knowledge. Teams should also have senior support and the mandate to reallocate resources and change internal structures as a part of digital transformation. Naturally, the team members need to be bought in and be passionate about the digital transformation process.

A key aspect that the digital team needs to consider and resolve is employee resistance. Employee resistance is likely given that digital transformation introduces change and uncertainty (Matt, Hess, & Benlian, 2015). Employees likely resist the proposed changes and need to be convinced of the reasons and objectives of digital transformation, especially when the change involves major changes to their daily tasks, and requires a possible new role and identity for organizations within value systems. Digital transformation involves a culture-driven process in which new organizational values need to be installed. To address the feeling of a mismatch about the employee's identity and the new organizational identity, it is important that employees are taken along in the transition toward new organizational values. Communication is therefore an important part of the organization of digital transformation. Organizations that undergo such radical change should repeatedly explain the reasons behind the digital transformation to employees, such that they are reminded of why the changes are necessary, and why the existing way of working is no longer desirable. Employees may challenge the idea that the traditional way of working is outdated. To facilitate acceptance, communication needs to highlight that old routines and ways of working are not inherently bad, but that novel ways may fit better in achieving the objectives of the organization.



Finally, employees may experience technological anxiety when they are forced to work with new and unfamiliar technologies (Meuter et al., 2003; Mokyr, Vickers, & Ziebarth, 2015). Employees may feel incompetent and be concerned with their job security as digitalization may render their tasks obsolete or replace them completely with robots. Effective supervisor and peer support may improve employee attitudes and behaviors toward digitalization (Nguyen & Broekhuizen, 2021). Supervisors can stress the importance of digital transformation and introduce new incentives that legitimize the need for change. Peers can help employees to overcome practical problems by demonstrating solutions and provide how- to instructions. Naturally, traditional training programs aimed at learning how to perform digital tasks can foster employees' confidence, ability and acceptance of new technologies.

Guiding questions:

- How to design a team capable of organizing the transition from the present to the future
- What organization culture is needed for digital transformation?
- How to resolve employee resistance and ensure employees' digital readiness, such that they embrace and use digital tools and technologies effectively?
- What requirements are placed upon employees' digital skills, and how can supervisor and peer support enhance employee confidence, ability and acceptance of new technologies?

Using a digital learning platform perspective

The digital learning platform provides the foundation of organizational learning, continuous improvement and innovation. To coordinate the digital initiatives and secure the learnings from digital initiatives and pilots, it is recommended to build a digital platform that informs users about the current status of projects and registers malfunctions.

As mentioned in the organization perspective, it is important to creating an organization receptive of digital change. Hence, it is important to install a culture directed at learning and experimentation, and that is tolerant towards making mistakes. Mistakes and blunders are unavoidable in such risky organizational pervasive endeavors. Rather than penalizing those individuals who have made the mistake, it is recommended to install a "fail fast, learn fast" culture, and let them share their lessons learnt from digital project initiatives to avoid similar mistakes happening in the future. A common practice to promote such a culture includes the introduction of "f#ck-up awards" that are handed out to individuals who have provided an opportunity for the organization to learn by failing.

Another effective way to detect, share and monitor errors is to install effective incident processes, and to build in detection systems or make people responsible for the reporting and addressing of mistakes. To internalize knowledge and distribute this knowledge to newcomers, it is important to build a repository of knowledge. Instruction videos, templates, and how-to guides may provide a check list and a blueprint of how to resolve common issues. Especially, when key digital personnel leave the organization it is important to know what capabilities and learnings these key persons have accumulated, what activities they have performed, and what kind of training they have had. The tracking of learning paths of individual employees can enable newcomers to follow similar learning paths in order to quickly build a thorough understanding of the digital processes within the organization.

Digital platforms provide the backbone of organizations and may serve as a perfect communication platform. High demands are placed on the development of such a communicative digital platform, as it transforms and communicates data input into valuable business insights. On the one hand, the digital infrastructure should be resilient and consistently perform the primary activities being resistant to external shocks. On the other hand, it should also be flexible enough to incorporate novel features as business models, products and services, and partnerships evolve over time. Transformation managers should realize that digital transformation is a continuous process that does not end after the launch of a new digital business model. Hence, sufficient means should be available to update and reinvigorate the existing business models. Organizations need to prepare for updates and continuous innovation to seize the opportunities provided by new developments and circumstances.

Conclusion: Ready to Act?

In this chapter, we have addressed the question of whether and how a digital transformation can be planned using digital roadmapping. There are many uncertainties and risks involved in a digital transformation, and these pose a significant challenge to managers. By designing and implementing a roadmap of the digital transformation journey, managers take small but important steps to help their organizations navigate their way to optimal digital transformation.

After synthesizing a simple three-phase approach guiding managers through the phases of digital transformation, we introduce four perspectives that help managers to ask the right questions to avoid blind spots and develop a richer understanding of the potential value and risks of digital transformation. The approach put forward supports an open dialogue with internal and external stakeholders to develop a clear digitalization objective, and to design and implement a plan to navigate from the present situation to realize significant improvement in the future.

The digital roadmapping approach is no "silver bullet" or simple recipe for success, due to the complexities and uniqueness of each organization and each practical situation. It also requires substantial investment in time and resources, and the chances of failure are still high. Nonetheless, by following this approach, the organization becomes activated and informs and engages relevant stakeholders to participate jointly in a transition with the aim to realize mutual benefits.

Finally, it is worth highlighting the fact that despite its high risks a well-implemented digital roadmapping process provides striking potential benefits to the organization in question, and to its customers. Appropriate and responsible use of the data made available has two key effects. First, it allows the organization to make better decisions by providing more accurate information into processes and problems that occur. Second, it enables the organization to be more receptive and responsive to technological changes. These two effects reinforce one another; having more accurate information makes the improved flexibility even more valuable (Drnevich & Croson, 2013). Therefore, managers are well- advised to consider the purpose, phases, and perspectives involved in digital roadmapping.

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#5

Tailoring the implementation of digital business

A diagnostic framework

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Groningen Digital Business Centre (GDBC) - Pubished June 2021

This chapter proposes a diagnostic framework that guides managers in developing a situationally appropriate and tailored implementation strategy for digital business. We distance ourselves from the view that there is one way of implementing digital business that will be effective in all circumstances. Rather, we clarify how an implementation strategy for digital business depends on the characteristics of the digital technology, the stakeholders involved, and the organizational context in which the digital business system is implemented.

Based on this insight, we propose a diagnostic framework for the implementation of digital business. The framework helps managers reflect on the complexity and risks involved from four domains of the digital business project and guides them in consciously developing a suitable implementation strategy. The framework identifies four generic types of digital business projects (uniform, pluriform, unfolding, and ambiguous) and proposes implementation strategies that match these types.

The framework supports an open dialogue with primary stakeholders to develop a shared understanding of project characteristics and align them with an appropriate strategy. It will help managers develop a deeper understanding of their project early on and in the course of the project, resulting in more tailored and flexible implementation trajectories.

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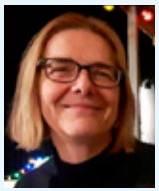

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The Idea in brief

The Issue	The Response	The Bottom Line
To manage digital business projects successfully, it is essential that managers adopt a tailored implementation strategy, which is based on a thorough understanding of digital technology in its context.	We propose a coherent, theory and practice-based framework that facilitates the diagnosis, implementation, and evaluation of digital business projects.	The framework supports an open dialogue with primary stakeholders to develop a shared understanding of the project characteristics and match them with an appropriate strategy.

Introduction

Digitalization in business may entail major organizational change. The changes can relate to a different way of communicating with customers and suppliers, redesigning business processes, introducing a new business model, implementing structural changes, acquiring new knowledge and skills, appointing digital experts, and intensifying the use of data. Digital transformation is a strategic reorientation, in which the business model, as well as the organizational culture will change fundamentally. The following case of the Judiciary system in The Netherlands illustrates how digitalization can involve a challenging change process (Greenhalgh et al., 2017).

> *".. The digitization of the judiciary system in The Netherlands must be redone, but less ambitiously. There will be no digital litigation for the time being. The current digitization project Quality and Innovation (QaI) will be discontinued. The project has cost around EUR 220 million so far, an exceedance of more than EUR 200 million from the original budget of EUR 7 million. The decision coincides with the publication of a critical report by an external ICT consultant. He has examined the progress of the project in recent weeks and concludes that it has largely failed. The council writes that the goals of QaI were too ambitious and the implementation too complicated for the project to be successful. It has been underestimated how complicated the digitization of the Judiciary system turned out to be because the work within the judiciary system is too complex. In addition, there was insufficient support within the judicial system for the project.." (NRC, April 20, 2018).*

Digitizing a Judiciary system is a technically complex endeavor. Moreover, here, the proposed modifications did not gain sufficient support from the work floor either. Indeed, digitalization often evokes competing interests and may create insecurity among employees. Due to such factors, digital business projects often turn out to be more complex than expected and regularly lead to unintended effects (Valuer, 2021).

In implementing digital systems, it may seem attractive to focus on the technology, which is tangible, and to get that operative as quickly as possible. Isn't technology the driver and enabler of change? These are false hopes as implementation of the technology accompanied with some end-user training will not automatically bring the intended change. Apparently, simple proven technology can be implemented quickly, yet the interconnectedness with the other elements of the work organization cannot be underestimated. Realizing the accompanying organizational change should receive explicit guidance from managers, also after the implementation. Organizational change resulting from digitalization requires a clear vision and a matching, proactive approach that starts at the concept phase and continues until digitization is fully integrated in the normal course of business. Responsible managers often wonder how they can organize and lead the implementation of a digital business project.

The academic implementation literature originates from different fields such as information systems, psychology, sociology, innovation management, and technical sciences. This knowledge is complementary but also fragmented. Consequently, it may offer little guidance in developing an appropriate implementation strategy. How to develop a strategy that addresses the tensions between incremental versus radical, partial versus integral, top-down versus bottom-up, dictatorial versus participative, linear versus iterative, techno-structural versus social-organizational, and blueprint versus emergent change (Boonstra et al., 2017; Deszca et al., 2019). The balancing of these tensions can be confusing for managers of digital business projects, especially when the trade- offs seem not that straightforward. Which choices form a coherent and suitable implementation strategy for their digital business project? Many gurus, consultants, and suppliers simplify the question by promoting one particular strategy, for example, an agile approach (Fernandez and Fernandez, 2016); the "silver bullet" for all one's digital business projects.

In contrast, in this chapter, we draw on patterned contingency thinking (Hanisch and Wald, 2012; Howell et al., 2020; Sauser et al, 2009; Shenhar, 2001) to propose a diagnostic framework that guides the choice for a situationally appropriate implementation approach. We distance ourselves from the view that there would be one way that will be

effective in all circumstances (Kwok et al., 2020). Rather, we aim to clarify how an implementation strategy depends on characteristics of the digital technology, of the interest groups or stakeholders involved, and on the organizational context in which the digital business system is implemented. This diagnostic framework can help managers not only to reflect on the complexity and risks involved in the digital business project but also guides them in consciously developing a suitable implementation strategy and monitoring it over time.

This framework directs the steps depicted in the process model shown in Figure 1. Since its development, it has been applied a number of times by experienced project managers, which has led to adjustments. The process model shows how the framework can be used before as well as during the project and enables responsible managers to perform an integrative diagnosis of the relevant project characteristics that have been categorized into three main domains: soft technology, hard technology, and stakeholders. Based on the domains the framework offers pointers for an appropriate implementation strategy. The model is particularly useful to facilitate a dialogue between the key stakeholders about the project characteristics, stimulating a shared vision for the project and a common understanding of the complexities and risks involved. Accordingly, risk managers can use the framework to identify and mitigate the socio-organizational and behavioral risks in the project. The framework can also be used to evaluate the progress of a project.

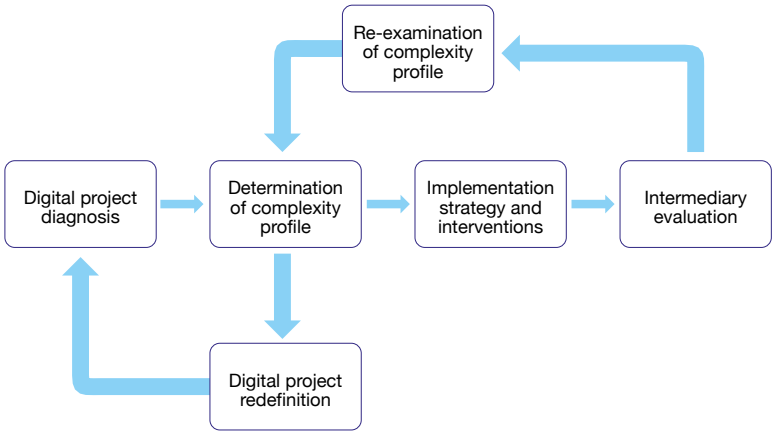

Figure 1. Process model for diagnosing the implementation of digital business projects

This diagnosis leads to an assessment of the complexities and accompanying risks of a digital business project (Bosch-Rekveld et al., 2011; Geraldi et al., 2011; Floricel et al., 2016).

This assessment may inform the development of an implementation strategies based on the main types that we outline in section 4, or to a redefinition of the digital business project if the complexity and the accompanying risks are considered too high (Figure 1). In the next section we explain the framework's background, after which we set out the implementation diagnosis in section 3.

The framework's background

The framework that we explain in this chapter is based on underlying models and theories that we will review below. Since the mid-1990s, scholars have proposed project management typologies based on contingency factors (Hanisch and Wald, 2012; Howell et al., 2010).

Stacey (1996) argued in his study "Complexity and Creativity in Organizations" that organizational processes and, therefore also digital business projects, are often complex and require creativity, making linear, top-down approaches less suitable. He argued that two main contingencies, the degree of certainty and the degree of agreement between interest groups, should determine the strategy. Based on these assumptions, Stacey distinguishes between simple, complicated, and complex projects (Greenhalgh et al., 2017; Daniel and Daniel, 2018). When the uncertainty is high and the degree of coordination and agreement is low, Stacey frames the situation as anarchistic, see figure 2. Many digital startups' structures and cultures are characterized by a high degree of self-organization. In a seemingly uncoordinated fashion, teams work in an experimental and agile way on digitalization within an uncertain environment.

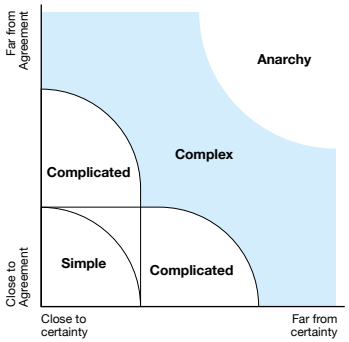

Figure 2. Stacey's agreement and certainty matrix (Stacey, 1996)

The digitization of the judiciary system, the example described at the beginning of this chapter, can be characterized by a high degree of uncertainty combined with limited support from the workplace. However, the project was managed in a traditional linear and top-down fashion, creating a misfit between the organizational context and the implementation strategy. This tension ultimately led to failure. In the following example, we outline a digital business project with a clear goal is outlined, but with probably a low agreement among key players, including importers and dealer networks; in terms of Stacey, this project can thus be characterized as complicated.

> *"... During the upcoming years, Volvo Cars aims to offer its electric cars only online. It wants to offer largely pre-configured electric models that can be ordered and delivered quickly and easily. Purchasing through the website should also include fewer steps. With this process re-design, the Swedish manufacturer seems to imitate the Tesla sales model, which is also characterized by relatively few options. The work of the Volvo dealers will focus on the delivery and maintenance of the vehicles." NU.nl, March 2, 2021.*

Relatedly, but in the context of policy implementation, Matland (1996) proposed four comparable implementation strategies derived from two similar contingencies: the degree of conflict and the degree of ambiguity. Matland's four strategies are: 1) administrative implementation with low conflict and low ambiguity. During administrative implementation, the goals are fixed, and the digital technology is known, the resources determine the results, and the management style is top-down. An example of a digital business project is a fishery products shop that establishes a webshop. 2) Political implementation with a high conflict potential yet little ambiguity. Stakeholders have diverging goals that may be incompatible. There is also disagreement about the resources that should be allocated to the digital business project. Negotiations and power relations determine the outcome. An example is the online sale of new cars by Volvo, as illustrated at the beginning of this section, where dealers are bypassed, and channel conflicts can emerge. 3) In experimental implementation, a low conflict potential is combined with high ambiguity. Implementers face a high degree of uncertainty that will require learning and experimenting. Step-by-step, project participants have to find their way through the fog by well-designed and monitored experiments, generating feedback on the way. An example is the development and deployment of nudging software to entice consumers to purchase digitally. 4) With symbolic implementation, there is both a high conflict potential and a high ambiguity, making the project extremely risky. This appears to be the case with the digitization of the judiciary system outlined earlier.

Figure 3. Cynefin framework (Snowden and Boone, 2007)

In the field of organizational decision-making, Snowden and Boone (2007) developed a similar model. Their well- known Cynefin framework demonstrates how managers should adapt their decision-making style to the nature of the decision and the context in which decisions are being made. They distinguish the following four contexts: simple, complicated, complex and chaotic for which they proposed four matching styles: best practice, good practice, emergent practice, and novel practice respectively (Figure 3). Starting from these earlier models, we divide digital business projects into four generic types from the dimensions of agreement and certainty, see figure 4. Within this framework, we will distinguish among uniform, multiform, unfolding, and ambiguous digital business projects. In part 4 of this chapter, we indicate which implementation strategies are appropriate for each of these projects types and which interventions may be most effective. In the next section, we will explain how you can diagnose a digital business project following the process model of Figure 1.

		Agreement among stakeholders regarding goals and means of a digital business project	
		High agreement	Low agreement
Certainty on the technology, the goals and means	Close to certainty	**A] Uniform digital business project**	**B] Pluriform digital business project**
	Far from certainty	**C] Unfolding digital business project**	**D] Ambiguous digital business project**

Figure 4. Diagnostic framework of four generic digital business projects

Four domains of digital business projects

Implementation issues can emerge within and between domains and phases of the project. In order to examine the possible issues systematically, a range of implementation domain models have been developed (e.g. Pettigrew and Whipp, 1991; Damschroder et al., 2015). Particularly within healthcare, extensive systematic reviews of empirical research have led to the elaboration of well-defined domain models complemented with practice- oriented checklists with success and fail factors per implementation domain (Fleuren et al., 2004; Rycroft-Malone, J., 2004; Damschroder et al., 2015). Most of these models are not explicitly aimed at digitalization, but rather at innovation and organizational change in general. Interestingly, Greenhalgh et al (2017) developed the NASS framework for digitalization projects in healthcare.

While the models are research-based, a limitation of these models is that they are merely descriptive. They help gain insights into the digital business project and raise awareness of the possible success factors and pitfalls. However, they often lack assessment criteria and guidelines or tools for developing an appropriate implementation strategy based on this assessment.

This section, draws on a simplified combination of existing domain models (Pettigrew and Whipp, 1991; Damschroder et al., 2015) that we have translated to an assessment framework for digital business projects. We selected these models because they are common, well-researched, generically applicable, and sufficiently robust. The framework suggests per domain what the most relevant factors are that need to be evaluated. For each factor in a domain, we propose several anchors to help assess the extent to which the digital business project is relatively simple or complex in terms of both (un-)certainty and (dis-) agreement (Greenhalgh et al. 2017; Stacey, 1996; Waltz et al., 2015). The domains we distinguish are 1) digital soft technology, 2) digital hard technology, 3) the stakeholders within the internal context and 4) the external context. This last domain encompasses the external stakeholders with power or a legitimate interest and the relevant developments digitalization in the external environment that may impact the project's process or outcomes. The assessment of these domains results in a risk profile of the digital business project. Next, in Section 4, we propose guidelines for arriving at an appropriate implementation strategy based on this risk profile.

Digital business domains

The central question is whether there is certainty and agreement about the digitalization that a business wants to achieve. This concerns the required digital technology or a mix of technologies and the envisioned change of the business model and the accompanying organizational change needed to accomplish the project's goals. To consider both domains in the model, we distinguish between what has been called the hard technology and the soft technology involved (Floricel et al., 2016), as we explain below.

Clarity and certainty about the required digital technology will be higher when digitizing a local art museum archive and lower when implementing innovative blockchain technology in processing containers in the Port of Rotterdam. The degree of agreement and commitment will be higher within a rental platform of campers (e.g., www.paulcamper.nl) than when an artificial intelligence-based healthcare decision-making system aims to replace the work of healthcare professionals (Moeini and Rivard, 2019). There can be large differences in the scope of a change in a digital business model. Developing a network of swap bicycles involves a limited organizational change compared to the transition from a chain of physical department stores, for example, Blokker, to a multi-channel model. The latter transition concerns a radical socio-technological change with far-reaching consequences for the organizational structure and culture and potential challenges regarding legacy systems. These examples demonstrate that it is relevant to distinguish between hard and soft technology. Hard technology concerns the existing and the required software and hardware, such as apps, operating systems, network infrastructure, and servers. Soft technology concerns the business knowledge and models, organizational practices, and activity systems through which business objectives are achieved as well as the hard technology within them (Bessant and Francis, 2005).

In diagnosing the success and failures of digital transformation projects, several factors have proved relevant, such as the scope, the role of legacy systems, the weighting of critical performance requirements (privacy, reliability), but also the expected dynamics of technological developments (Bakhsi et al., 2016, Bosch Rekveldt et al., 2011; Morcov et al., 2020). Actor-based factors also play a role, such as the innovativeness of the organization (s) involved and the project managers' familiarity with digital technology (Van Offenbeek, 1993). In Table 1 (Soft Technology) and Table 2 (Hard Technology) these factors are elaborated based on the literature and the practical experiences of managers.

Table 1. Assessment of the project's soft technology (domain 1)

Factor	A **Uniform digital business project** *Simple, few socio-political and techno-logical complexities*	B **Pluriform digital business project** *Low uncertainty, high socio-political complexities*	C **Unfolding digital business project** *High technological complexities; low sociopolitical complexities*	D **Ambiguous digital business project** *Multiple socio-political and technological complexities*
Existing soft technology: complexity and familiarity	The tasks that the digital technology will support are relatively easy.	The tasks that the digital technology will support are relatively easy but still conflict-prone.	Many and complex task interdependencies need to be digitalized, not conflict prone.	Many and complex task interdependencies that need to be digitalized, conflict-prone.
Existing soft technology: stability and predictability	The tasks that the digital technology will support are stable with predictable variations.	The tasks are stable but powerful stakeholders may resist changes in soft technology.	The tasks that the digital technology will support or replace require significant organizational reconfiguration.	Digital technology requires significant organizational reconfiguration. Powerful stakeholders may resist.
Change in soft technology: digitalization history and maturity	The project builds on earlier, successful digitalization experiences or best practices.	The project builds on earlier, successful experiences, but there are bound to be winners and losers.	The project departs from earlier, successful digitalization experiences and developed best practices.	Earlier projects failed or the project logic departs from earlier, successful digitalization experiences, and there are bound to be winners and losers.
Change in soft technology: cultural risk in terms of strength and alignment	Strong culture with which the digitalization effort is well aligned.	The digitalization effort is aligned with the culture that is homogeneous, but the culture is weak and is not a driving or integrating force.	Heterogeneous (sub)cultures involved that seem to be aligned with the digitalization and driven by a shared goal for the digitalization effort.	Diverse strong (sub)cultures with competing logics and values that do not align with the digitalization effort.
Change in soft technology: Disruption of users' work organization	There is only a small gap between the existing process and the new digital technology, problems with affected users are unlikely.	There is a small gap between existing processes and the new digital technology, but conflicts with affected users are likely. Users are not ready to change and to adapt.	There is a large and unknown gap between the existing and the new digital technology, but conflicts are unlikely. Users agree, are supportive, and keen to learn and to adapt.	There is a large and partially unknown gap between the existing and the new digital technology, problems with affected users are likely.
Change in soft technology: internal process dependencies	There is an established number of process interdependencies between existing processes and the new digital technology and conflicts with process owners are unlikely.	Disagreement with established internal process owners regarding the impact of the digital technology on the existing processes is likely.	There are many yet unknown internal process interdependencies but disagreement among process owners is unlikely.	There are many yet unknown internal process dependencies, diverging views with process owners are likely.

Table 2. Assessment of the hard technology of a digital business project: domain 2

Factor	A **Uniform digital business project** *Simple, few socio-political and techno-logical complexities*	B **Pluriform digital business project** *Low uncertainty, high socio-political complexities*	C **Unfolding digital business project** *High technological complexities; low soci-opolitical complexities*	D **Ambiguous digital business project** *Multiple socio-political and technological complexities*
Existing digitalization: legacy systems	The digital technology will replace legacy systems without major disruptions.	Legacy systems will not be easily replaced, this will cause conflicts with those who cherish these systems.	The new digital business technologies have many interfaces with other systems, it is likely that experts cooperate effectively to achieve compatibility.	Many dependencies with other technologies/ systems, disagreement among technical experts regarding the realization of connectivity is likely.
Existing digitalization: scope, size, and criticality	The affected digital systems have limited scope and size or support a peripheral business function.	The digitalization effort is huge, will affect more, interrelated, and core or critical digital systems with different owners, which increases conflict potential.	The scope and size of the affected digital systems are potentially large and yet undetermined. However, internal stakeholders are cooperative and comfortable with this change under uncertainty.	The scope and size of the affected digital systems are uncertain and may affect many core processes, affected system owners may disagree with the direction, scale and scope.
Digital solution's innovativeness and substitutability	Generic plug and play, requiring minimal customi-zation, easily substitutable when the supplier withdraws. Proven technology.	Proven technology, yet influential user groups favor different suppliers and may face substantial switching costs dependent on the technical solution.	Innovative technologies for which little expertise is available. Given the unfamiliarity, no strong preferences have been developed yet. Technical experts and supplier(s) are trusted not to withdraw.	Large scale bespoke solutions, vulnerable to supplier withdrawal.
Digital solution's dependency on external processes	The digital business system has few external process inter- dependencies and will not be affected by rapid technological developments.	There are only a few external process interdependencies, but the dependence on these external developments is high and the owners of these developments may have mixed or conflicting interests.	There are many, dynamically emerging external process interdependencies, but conflicts with external process owners seem unlikely, relevant process owners interests are compatible with the project's logic.	There are many emerging external process interdependen-cies, conflicts with external powerful process owners are likely due to diverging views and conflicting interests.

Stakeholder analysis

In addition to the analysis and assessment of the implementation factors per domain on the digital business project, the stakeholders need to be identified and their characteristics analyzed (e.g., Aaltonen and Kujala, 2016). The particular analysis proposed here focuses on stakeholders' influence, willingness to change, and change capacity. We separately group them into internal (table 3) and external (table 4) stakeholders. The internal stakeholders are the actors in the focal organization or in an organizational network set up specifically for the project.

Table 3. Analysis of the salient internal stakeholders: domain 3

Factor	**A** **Uniform digital business project** *High capability and readiness of stakeholders*	**B** **Pluriform digital business project** *Socio-political complexity, high capability, and low readiness of stakeholders*	**C** **Unfolding digital business project** *Technical/functional complexity, low capability, and high readiness of sstakeholders*	**D** **Ambiguous digital business project** *Multiple complexities, low capability, and low readiness of stakeholders*
Top management capability	The digital business project benefits from a consistent, sustainable and pro-active, visible top management support and project ownership.	Conflicts about the digital transformation between the project team and top management or within the top management are likely. Top management is ambivalent or internally divided.	Top management consistently supports and owns the digital business project but may want to adapt the goals due to environmental turbulence.	Support from top management regarding the digital business project is inconsistent and ambiguous. Conflicts are likely. Project ownership and sponsorship is not stable.
Top management commitment Resources	Clarity about the necessary resources, and these are available for the digital business project, in terms of finances, staff and expertise.	Disagreement about the necessary resources, negotiations to make the resources available are ongoing.	Uncertainty about the necessary resources, given the novelty of the project, but there is a confidence that resources will be made available when needed.	Uncertainty about the necessary resources, given the novelty of the projects. Discussions and conflicts about the availability of resources are likely.
Project team	The digital business project team is stable and experienced. The members are available and committed to the project. They are perceived as credible by the adopting organization.	The digital business project team members do not fully agree about the operational project goals, means, and tactics. Conflicts within the project team are likely.	The harmonious project team is uncertain about the feasibility of the project. They cannot boast of extensive experience with this type of projects.	Within the project team members disagree about the project goals and the overall direction of the project, and the implementation strategy.
Other internal stakeholders with a legitimate interest	Powerful internal stakeholders generally agree regarding the digital business project goals and required resources.	The project causes disagreement about project goals, means, and implementation approach among powerful internal stakeholders.	Project goals are fluid, but disagreement among powerful internal established and emerging internal stakeholders is not likely.	Project goals are fluid and diverging views about these changing high-level project goals among established and emerging internal stakeholders are likely.

Table 4. Analysis of the salient external stakeholders: domain 4

Factor	A **Uniform digital business project** *Simple, few socio-political and techno-logical complexities*	B **Pluriform digital business project** *Low uncertainty, high socio-political complexities*
Digital technology partner	The digital technology partner is experienced, the technology is straightforward, and we seek to develop a long-term relationship with this partner. Conflicts are unlikely.	Conflicts with the digital technology partner are likely due to the short-term relationship and diverging interests between the adoption and technology partners.
External stakeholders such as suppliers and customers	The digital business project has a stable and harmonious external environment. External stakeholders are supportive, conflicts are unlikely.	The digital business project has a stable but controversial environment. Conflicts with external stakeholders are likely.
	C **Unfolding digital business project** *High technological complexities; low sociopolitical complexities*	**D** **Ambiguous digital business project** *Multiple socio-political and technological complexities*
Digital technology partner	The digital technology is new and complex. The technology partner is strong (in terms of size, age, and experience), we wish to develop a long-term relationship with this partner. Conflicts are unlikely.	The digital technology is new and complex. Our technology partner is not experienced in dealing with these new technologies. Conflicts are likely due to diverging viewpoints and interests.
External stakeholders such as suppliers and customers	The digital business project has a turbulent but harmonious and supportive external environment. Conflicts with established or emerging external stakeholders are unlikely.	The digital business project has a turbulent and controversial environment. Conflicts with existing and emerging external salient stakeholders are likely.

Tailoring implementation strategies of digital business

Informed by the risk profile that results from the digital business project diagnosis, implementers can develop an appropriate overall implementation strategy. The guidelines presented in this section are derived from a range of situational change and project management theories (Cameron and Green, 2019; De Caluwe and Vermaak, 2003; Van Offenbeek and Koopman, 1996; Maylor et al., 2013; Maylor and Turner, 2017; Moeini and Rivard, 2019; Snowden and Boone, 2007; Waltz et al., 2015). To the extent needed, they have been translated to the context of the implementation of digital business projects. We outline four generic implementation strategies that match the main risk profiles that may result from the assessment. We will discuss these strategies in the following order, and we conclude with a reflection on hybrid risk profiles:

1. Planned strategies match with uniform digital business projects;
2. Stakeholder management strategies match pluriform digital business projects;
3 Learning and experimenting strategies match unfolding projects;
4 Dialogues and future scenarios suit ambiguous projects.

1. Planned strategies match uniform digital business projects

Uniform digital business projects are characterized by a high degree of certainty, which implies a relatively stable environment and a high degree of agreement among stakeholders. A deterministic way of thinking characterizes planned implementation strategies. Sufficient resources are released, and project activities are identified and allocated to project participants. This means that clear project goals and a blueprint of technical and functional requirements can be formulated. Such a plan usually has predefined phases and activities with milestones at which decisions are based on predefined go-no go criteria. Advanced project planning techniques and tools are often applied, including activity network techniques to identify critical paths (e.g. dynamic programming, decision trees) and project risk analysis techniques (e.g. scenario planning) (Pich, Loch and De Meyer, 2002).

A technically competent project team knows what is expected and carries it out. Communication about the project is mainly unequivocal and takes place through known channels in a direct way. Intensive, interactive communication directed at sense-making and negotiation is less invested in. The implementation of a timely training plan direct at the integration of the system in the work routines, the availability of user support and

the installation of an end-user platform of some sort for feedback ensure that employees can effectively use the digital technology to their and the organization's benefit, see table 5.

Table 5. Planned strategies

	Close to agreement	*Far from agreement*
Close to certainty	**A) Planned strategies** **Role of top management:** Take the initiative, be committed and provide sufficient resources. **Approach:** Develop a blueprint of the desired end situation. If necessary, use external experts. Apply advanced planning techniques. Define formal stages with milestones. Make decisions to make progress irreversible. Formulate go-no-go criteria. Learn from best practices from other organizations. **Team:** Appoint a technically competent project manager and project team. Protect the project team from external interruptions. **Internal context:** Communicate unambiguously with relevant stakeholders about project progress. Extensive interactive communication is not necessary. Train and educate, provide interactive help. **External environment:** Apply an action-oriented approach with technology partners and other stakeholders. Inform external stakeholders proactively throughout the project.	**B] Stakeholder management strategies**
Far from certainty	**C] Learning and experimenting strategies**	**D] Dialogues and future scenarios**

2. Stakeholder management strategies match pluriform digital business projects

Pluriform digital business projects are characterized by a stable environment and a high degree of certainty combined with little agreement among influential stakeholders: powerful interest groups think differently about the objectives of the digital business project and about the resources required to achieve these goals. Project leaders are recommended to assess the power and interests of stakeholders and to consider how to approach the different points of view. This requires, among other things, a politically experienced project leader, as well as a timely and comprehensive involvement of influential stakeholders. Negotiations, adjustments (Waltz et al., 2015), strategic use of time, pilots and use of incentives are typical strategies that suit multiform digital business projects. Sometimes it can be wise to limit the scope and size of a project so that the steps and thus the concessions become smaller. It can also be effective to coordinate negotiation processes formally and transparently and to create breaks for breathing time during a project (Doloi, 2013), see table 6.

3. Learning and experimenting strategies match unfolding projects

Unfolding projects are characterized by uncertainty combined with agreement among stakeholders. When digital technology is new or changing rapidly, or when the internal requirements or the requirements of the external environment (e.g. customers) are subject to change but are not necessarily contradictory (Eisenhardt and Tabrizi, 1995), learning and experimenting are effective implementation strategies (Highsmith, 2009). A learning and experimenting strategy is based on a global and flexible vision instead of a specified end state. The project's business case is global, and the resources required are not entirely clear. In terms of the internal context, top management supports the project and is also part of the learning process. Those involved in learning and experimenting support the flexible project goals and contribute fully to the team effort (Fernandez and Fernandez, 2016).

Learning and experimenting strategies often relate to relatively small and incrementally developing digital business projects. In terms of content, the problem is generally understood, and project teams often use agile and scrum-like methods (Fernandez and Fernandez, 2016). In terms of the internal context, the vision must be supported by top management (Boonstra, 2013) and by other influential internal stakeholders. The same applies to external parties with an interest in the project.
Typical implementation approaches include continuous consultation between team members and dialogues with internal stakeholders and technology companies and customers, in agile and scrum-like sessions (Fernandez and Fernandez, 2016), leading to interim results. Incrementalism, short-term sprints, and flexible longer-term planning are part of this. Functional and technical requirements change gradually and solutions evolve. The leadership style stimulates self-organization instead of top-down management. Continuous interactions between different actors, including experts and business partners, are necessary, see table 7.

Table 6. Stakeholder management strategies

	Close to agreement	*Far from agreement*
Close to certainty	**A) Planned strategies**	**B] Stakeholder management strategies** **Role of top management:** Support the project manager and the team. Provide sufficient resources or don't get started. **Approach:** Reduce the size and scope of the project. Assess power relations and interests. Find an over-arching, common goal and translate this into separate ways of thinking and interests. Make adjustments to accommodate losers. Use time strategically. Use pilots to show the project outcome. Compensate losers. Be flexible in the project approach and planning, create freedom of choice and customization. **Team:** Appoint a politically experienced project leader with legitimacy who knows the organization or network well. **Internal context:** Involve and activate influential internal stakeholders in a timely manner. Coordinate negotiation processes. Build-in breaks for breathing with attention to what has already been achieved. **External environment:** Negotiate contracts and exit strategies with external partners, such as technology suppliers. Involve external stakeholders early on, assess their interests and power, and negotiate conflicts of interest. Try to reach an agreement on critical topics in good time.
Far from certainty	**C] Learning and experimenting strategies**	**D] Dialogues and future scenarios**

Table 7. Learning and experimenting strategies

	Close to agreement	*Far from agreement*
Close to certainty	**A) Planned strategies**	**B] Stakeholder management strategies**
Far from certainty	**C] Learning and experimenting strategies** **Role of top management:** Create an environment for experimentation, learning, and failure. Provide continuous interactions between different actors, including experts and business partners. Encourage self-organization. Provide adequate resources. **Approach:** Use agile and scrum methods. Implement step by step. Short term sprints and flexible longer term planning. Let requirements and solutions evolve. **Team:** Appoint a project leader and team members who have experience with agile methods. Communicate regularly with the project environment to adapt. **Internal environment:** Regular collaboration and communication with internal stakeholders. Promote continuous interactive communication. **External environment:** Develop a partnership with technology partners based on solidarity. Keep external stakeholders well informed, involve them in crucial choices that affect their interests.	**D] Dialogues and future scenarios**

4. Dialogues and future scenarios match ambiguous projects

Ambiguous projects are characterized by a high degree of uncertainty and little agreement. In such situations, different internal and external interest groups dominate the course of events during the project. The outcome cannot be predicted as it depends on the changing views of powerful actors and environmental developments (Snowden and Boone, 2007). The garbage-can decision-making model (Cohen et al., 1972) is an appropriate metaphor for such ambiguous situations. Streams of stakeholders, problems, options, and solutions emerge. Choices are difficult to make and execute as the project is dominated by ambiguous goals, uncertain technologies, and fluid

participation (Pich et al., 2002). Multiple solutions are pursued in parallel, with the best chosen when it emerges by chance (Sobek et al., 1999).

The latter projects require investments in defining and initially limiting their boundaries, developing future scenarios, and debating the project recurrently among those involved. External and internal stakeholders, including the top management, need to participate in these debates. Due to the potential conflicts present in these projects, the suggestions made for multiform digital business projects also apply. Stakeholders with power and interests are intensively involved, and different views should be explicitly addressed and resolved through negotiations and coalition building. Neglecting them will most probably backfire. Patience and time for reflection are also recommended (Snowden and Boone, 2007). See Table 8.

Table 8. Dialogues and future scenarios

	Close to agreement	*Far from agreement*
Close to certainty	**A) Planned strategies**	**B] Stakeholder management strategies**
Far from certainty	**C] Learning and experimenting strategies**	**D] Dialogues and future scenarios** **Role of top management**: Participate actively in strategic dialogues. Encourage dissent and promote diversity consciously. Provide adequate resources. **Approach:** Develop future scenarios. Make use of experiments and pilots. Use methods that can help generate ideas, encourage creative and innovative approaches. **Team:** Appoint a project leader who is experienced in complex and unpredictable contexts. Team members should feel comfortable with a high degree of uncertainty. **Internal environment:** Debate the project with knowledgeable internal stakeholders. Invite internal experts to stimulate discussion. **External environment:** Involve outside experts and opinion leaders to stimulate discussion. Develop an appealing vision of the future and include external partners. Organize dialogues with potential future partners to assess possible collaboration

5. Hybrid risk profiles

Digital business projects have many relevant features and characteristics on which they may vary from one another. This means that managers will come across projects that cannot be straightforwardly classified in one of the proposed categories. The soft and hard technology, the project content, the internal context, and the external environment may point towards different configurations. Certain factors can yield uncertainty and disagreement, while other factors of the same project may be clear and unequivocal. Take the example of a standard enterprise software system. Here, the technology may be straightforward. Powerful and unwilling stakeholders can characterize the internal context. The external environment may be highly unpredictable by a high dependence on the technology partner and lacking insights on future customer reactions. This implies that a project diagnosis must take a differentiated look at the technology, the internal context, and the external environment. Furthermore, sensitivity to interactions between these domains needs to be fostered. Different types of strategies and associated interventions may be appropriate for different domains of the same project in practice. Projects can also change during their lifetime. For example, functional and technical requirements can be diffuse at the outset and become clearer after probing during later phases of the project. This means that projects may require a combination of implementation strategies that need adaptation over time as the digital business project evolves.

Conclusion

The purpose of this chapter was to present a coherent and theoretically grounded framework and process model that can help managers diagnose digital business projects to develop an appropriate implementation strategy. We used patterned contingency theory as a theoretical lens. Guided by this lens, we based the framework on a synthesis of knowledge about digital business, project complexity, project typologies, change management, and project management strategies. The resulting framework assesses four primary domains - soft and hard technology and internal and external project stakeholders – that are assessed on two contingencies: agreement and certainty. This assessment results in four generic digital business project types and four corresponding project management strategies. We recognize that a hybrid strategy may be called for, e.g., when simple digital technology is combined with a complex internal context and turbulent external environment. The model proposed in this chapter also creates awareness of hybrid implementation strategies. Our model promotes awareness among managers to develop tailored strategies to balance tensions and combine contrasting strategies and interventions over time (Boonstra, 2013; Smith and Graetz, 2011).

A second caveat is that the use of this diagnostic framework provides a subjective, or ideally intersubjective, assessment of the domains of a digital business project and the resulting consequences for an implementation strategy. The application is subjective because, ultimately, managers and other key actors involved in the diagnosis have to assess and weigh each domain based on the characteristics discussed. To prevent the 'blind' application of the framework, we explained the assumptions behind the various complexities and risks. Also, the framework indicates general measures to control the risks or reduce complexities, but these are guidelines rather than operational prescriptions.

Various applications are conceivable for the described framework, depending on the phase, the client (s), and the digital business project context. The framework outlined in this chapter can for example, be used:

- as a risk analysis of an ongoing project on behalf of the project owners,
- as a resource for project managers to support or evaluate their implementation strategy,
- a checklist at the start of a digital business project to jointly define the focus areas of the project and arrive at an estimate of the feasibility.

Let's remember that the diagnosis is a snapshot: project ambitions, context factors, and the implementation strategy can change along the way. When far-reaching changes occur during the process, re-assessment is required.

We have experienced that thinking about the nature of a digital business project and its boundaries is helpful before arriving at a final evaluation of the four main domains. In our view, the diagnostic framework is most useful as a sense-making vehicle. It may help negotiate a shared vision and ambitions between key actors (client(s), project leaders, user managers, system administrators, project consultants). One option is first to assess the domains individually and then discuss them. A clear, joint image of the digital business project is created, in which the different perspectives have been incorporated. By talking about concrete characteristics that may lead to failure or success, it becomes clear whether the expectations concerning goals, yields, and responsibilities are synchronized.

We hope the framework will help managers develop a deeper understanding of their project early on and during the project, resulting in more tailored and flexible implementation trajectories. We welcome user experiences, feedback, and recommendations to develop further and improve this framework.

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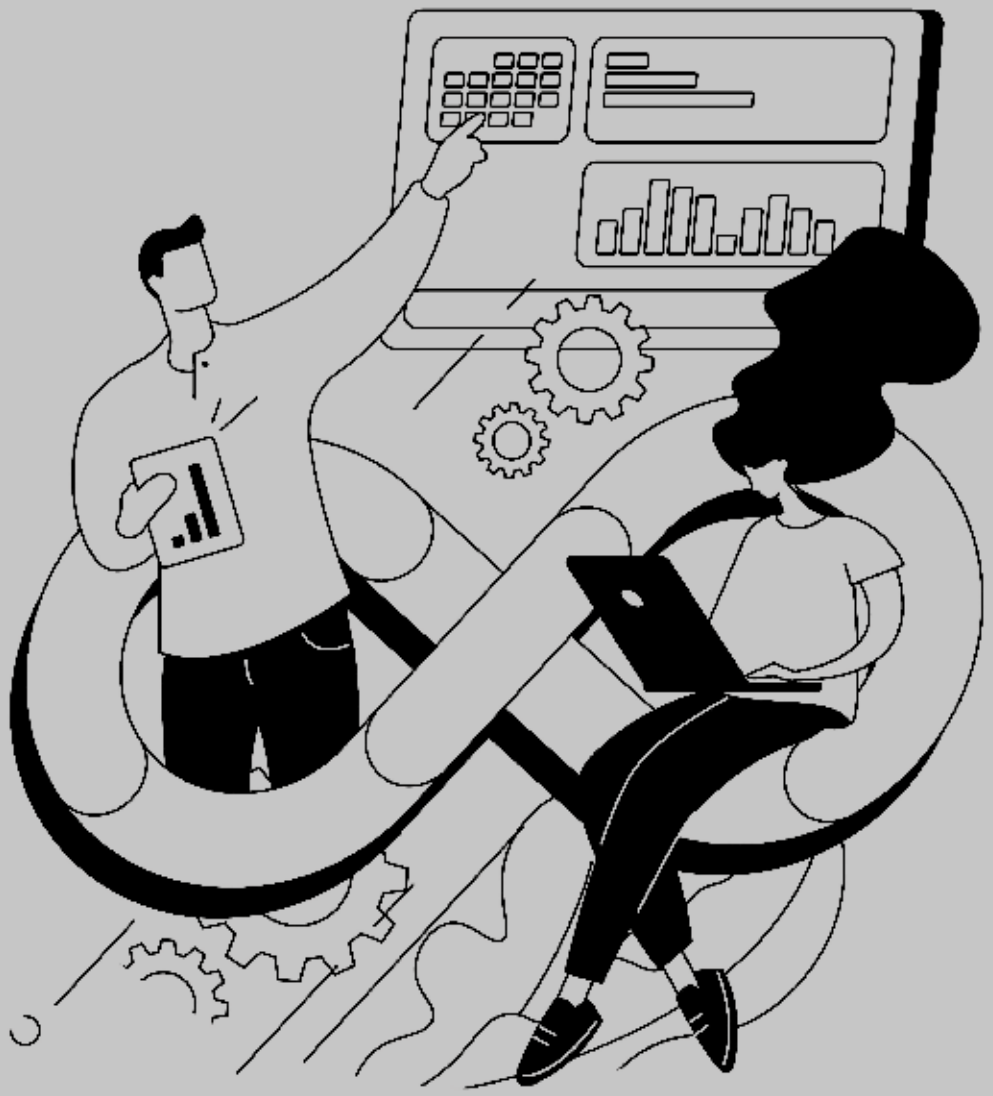

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#6

Digital Governance:

How Blockchain Technologies Revolutionize the Governance of Interorganizational Relationships

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Digital technologies are changing the business world at a rapid pace, bringing new challenges and opportunities for companies. This is especially true for blockchain technologies, which are increasingly being used to manage interorganizational transactions. Blockchains are distributed ledger technologies where data is replicated, shared, and synchronized over a network of computers without central servers.

The main advantages of blockchains over standard contracts are that they are particularly secure, easily scalable, and comparatively inexpensive. At the same time, blockchains also present managers with a number of challenges in terms of network participation rules, control mechanisms, technology choices, and legal affairs.

In this book chapter, we discuss these aspects and provide practical guidance for decision-makers. This discussion makes it easier for managers to determine whether and under what conditions blockchains offer an advantage for their business.

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The Idea in brief

The Issue	The Response	The Bottom Line
Many interorganizational relationships are hampered by a lack of trust, the complexity of governing multi-party transactions, and the costs of designing and enforcing contracts.	Blockchains facilitate the governance of inter-organizational relationships by creating a system of "trustless trust," providing seamless scalability options, and eliminating the need for formal contracts.	Is blockchain the holy grail of governance? No, the design and implementation of blockchain technologies as governance instruments pose managerial challenges in terms of network composition, control, technology, and legal affairs.

Why Blockchains Revolutionize the Governance of Interorganizational Relationships

The governance of interorganizational relationships is a central challenge in business life. Interorganizational relationships exist within a range of contexts, from supply chains, licensing, cobranding, and franchising to strategic alliances and joint ventures (e.g., Parmigiani & Rivera-Santos, 2011). The main governance challenge in such contexts lies in the need to enable collaboration while building trust and protecting partners against opportunistic behavior (Gulati, Wohlgezogen, & Zhelyazkov, 2012; Hoffmann, Lavie, Reuer, & Shipilov, 2018). Traditionally, the governance of interorganizational relations is based on formal contracts and informal mechanisms such as trust, which arises from repeated interactions (Gulati, 1995; Poppo & Zenger, 2002). More recently, however, a third mode has emerged that is increasingly redefining how businesses govern their relationships with each other: blockchains (Goldsby & Hanisch, 2022; Lumineau, Wang, & Schilke, 2021). Blockchains are decentralized data storage technologies (also known as distributed ledgers) that permit organizations to store and exchange information in a seamless, transparent, and tamper-proof way. These digital technologies enable new ways of governing transactions that reduce the inherent transactional risks while increasing efficiency.

For example, when the US wholesaler Walmart sought to increase efficiency and transparency in its supply chain management, it looked beyond traditional governance tools (The Linux Foundation, 2019b). Walmart's goal was to improve the traceability of products from manufacturer to store, to provide confidence in food safety, and to ensure a reliable and cost-effective supply chain. Walmart decided to implement a blockchain-based solution that allows for the secure exchange of real-time food information while at the same time provides tamper-proof data storage and access for all involved parties based on a decentralized data infrastructure. The blockchain-based cloud network provides participating retailers, suppliers, farmers, and food industry vendors with data from the entire food ecosystem to enable better traceability, transparency, and efficiency. Blockchain technology allows supply chain information to be securely stored and accessed through decentralized servers, enabling Walmart and its partners to track the quantity, quality, price, and location of a product from the moment the food is produced until it reaches the point of purchase by Walmart's customers. This creates a high level of transparency and security for all parties involved while improving the efficiency of the logistical processes.

What makes blockchains truly special is their decentralized and immutable architecture, which can provide considerable security and efficiency benefits. Because blockchain data are stored in a decentralized way, transactions do not need a central authority to verify, approve, or enable a transaction. In this way, blockchains cut out the "middleman" (e.g., an agent or a traditional platform) that is typically needed to establish trust in a transaction. Instead, the redundant data structure provides a safety net and improves reliability without the need for a central (and costly) intermediary. In addition, once a transaction has been validated and approved, it cannot be cancelled, reversed, or modified by any member of the network under any circumstances, which is referred to as immutability. From a technical perspective, this is achieved by storing and validating records across a network of decentralized nodes or computers that constantly check new data entries (see Figure 1 for a visual illustration). More specifically, blockchains use a verification algorithm over a network of distributed computers, each of which stores a copy of all data and constantly checks for changes to ensure that new records are added to the blockchain only when the network reaches consensus (usually by some form of algorithmic majority). Whereas a server-based network is vulnerable due to its central point of attack, blockchains and the redundancies they create are much more difficult to manipulate.

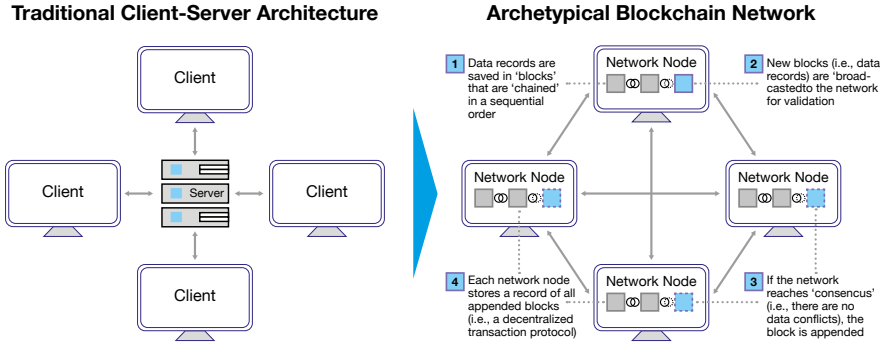
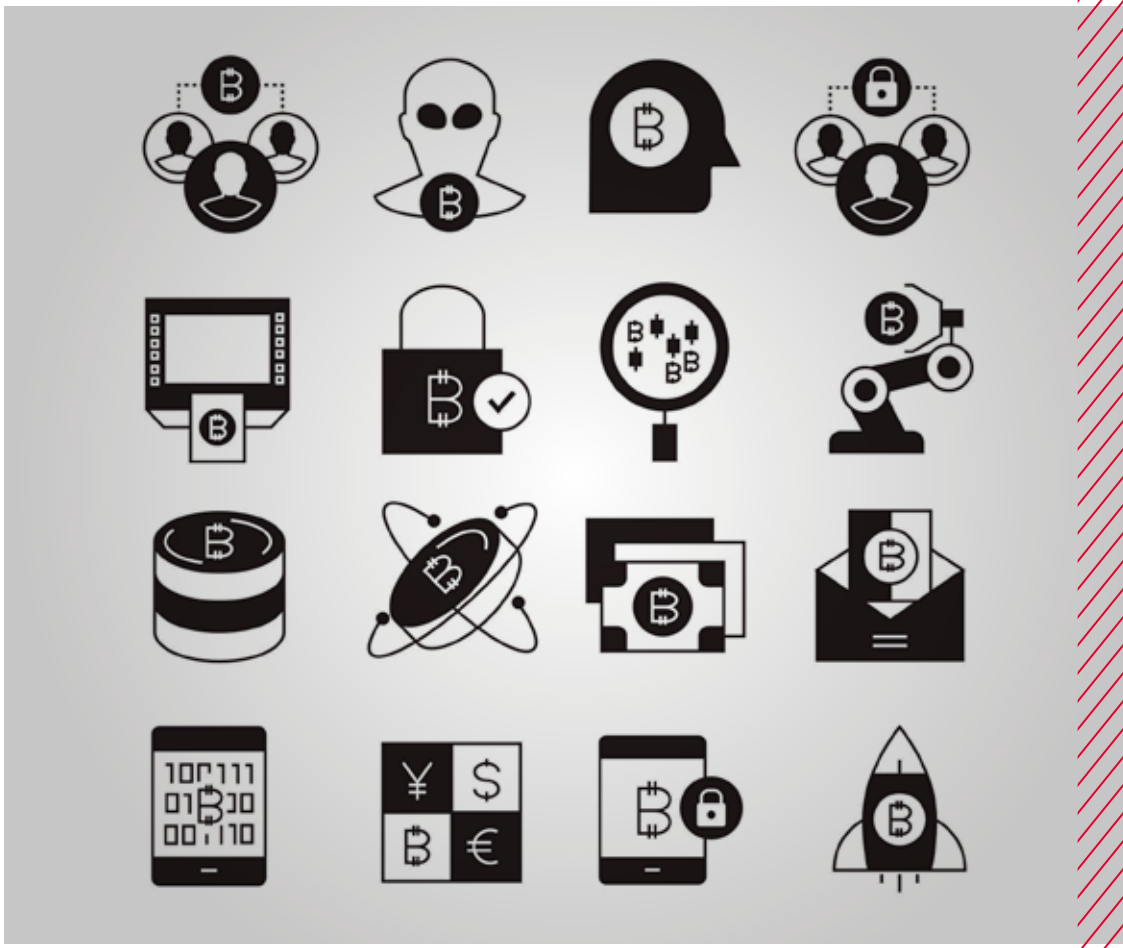


Figure 1. Visual comparison of server and blockchain networks

Blockchains are a true revolution in the way transactions can be governed because they create trustless trust: as long as participants trust the underlying blockchain technology, there is no need to trust individual participants in the blockchain because no individual participant can change the blockchain without consensus in the network. Blockchains thus shift transactions from an actor- or institution- centered form of trust to a form of technology-induced trust. Imagine a world where securities are no longer traded on the stock exchange, a world where social media giants no longer collect and appropriate large amounts of user data, or where a digital platform for ride hailing and room sharing is no longer necessary—all because information is stored in a decentralized way and can be exchanged in a peer-to- peer and tamper-proof manner. This critical feature of blockchains lays the ground for transactions that would not otherwise be possible. For example, IBM partnered with mining companies to develop a blockchain-based web application that prevents supply chain participants from purchasing cobalt that has been mined using child labor (Lewis, 2019). Since blockchains cannot be corrupted, it is possible to conduct business even in challenging contexts such as those with institutional weaknesses or ethical concerns. Overall, blockchain technologies allow companies to interact in a secure, adaptable, and limitless way without the need for intermediaries, thus bearing the potential for a profound disruption in interorganizational governance.

The possible applications of blockchains cover a broad spectrum and essentially extend to all areas in which a transaction between individuals or organizations occurs. Whenever individuals or organizations collaborate and require efficient, secure, and adaptable governance solutions, blockchains can be a viable option. In fact, a recent paper identified more than 1,100 start-ups working on blockchain-based business solutions (Friedlmaier, Tumasjan, & Welpe, 2018). The technology has been used in



multiple contexts such as social media platforms, logistics, natural resource extraction, strategic alliances, and clearing systems for banks. The decision to implement a blockchain is mainly motivated by the reliability of the technology for the exchange of information in a transparent and hard-to-manipulate way, as well as its easy scalability and dynamic features. Moreover, blockchains can be used to share information more selectively, more privately, and more securely as evidenced by the digital IDs they employ that allow individuals to regain control over personal information (World Economic Forum, 2019). Table 1 provides an overview of exemplary use cases of blockchain technologies in different industries. These examples show that blockchains can be applied in a variety of scenarios far beyond the popular cases of digital currencies such as bitcoin (Nakamoto, 2008).

Table 1. Examples of blockchain use cases

Organizations	Context	Blockchain Purpose	Main Governance Benefits
Ford, IBM, LG Chem, Huayou Cobalt	Materials	Blockchain ensures resource provenance with the aim of preventing child labor for mining cobalt in the Democratic Republic of Congo (Lewis, 2019).	Tracking and traceability
Walmart	Retailing	Blockchain improves the traceability and safety of food and increases the ability to respond in the event of a food incident or food scandal (The Linux Foundation, 2019b).	Tracking and traceability
Seal	Marketing	The blockchain-based tracking of articles makes it possible to identify counterfeit brands and thus protect brands (seal, 2022).	Tracking and traceability
CryptoPunks	Art	Blockchain technology is used for registering and collecting data about digital art to prevent copyright infringements (Larva Labs, 2022).	Tracking and traceability
Peer Social	Social Media	Blockchain provides the possibility to store user data locally on individuals' devices so that the network service only needs to store an artificial digital identity to interact with other users, thus giving users greater control over their personal data (Peer Social Foundation, 2022).	Trust and transparency
Honeywell	Engineering	Blockchain supports an online marketplace for aerospace parts (The Linux Foundation, 2019a).	Efficiency and optimization
U.S. Food and Drug Administration, KPMG, Merck, Walmart, and IBM	Biopharmaceuticals	Blockchain reduces the time needed to trace a prescription drug from up to 16 weeks to two seconds (IBM, 2019).	Efficiency and optimization
KLM	Accounting	Blockchain facilitates intercompany accounting settlements between KLM and its subsidiaries (Ledger Insights, 2020a).	Decentralization and immutability
Singapore Airlines	Travelling	Blockchain loyalty program allows travelers to convert their miles into digital tokens that can be spent at multiple retailers (Ledger Insights, 2018).	Decentralization and immutability
Cambodia	Government	Blockchain-based cryptocurrency is supposed to reduce inflation in Cambodia (NASDAQ, 2020).	Decentralization and immutability
Deutsche Börse	Finance	Blockchain enables peer-to-peer movement of digital securities (The Linux Foundation, 2018).	Security and risk mitigation
AIG, IBM	Insurance	Blockchain helps to manage complex international insurance coverage (Barlyn, 2017).	Security and risk mitigation

Even though blockchains are currently used mainly by large firms or start-ups that offer blockchain-based services, the technology is equally relevant for small- and medium-sized enterprises. A frequent application of blockchains is in the creation of smart contracts, which function as the rulebooks for blockchains (Murray, Kuban, Josefy, & Anderson, 2021). For instance, smaller companies often have the problem of unpaid bills, which then have to be claimed through expensive debt collection agencies. Such inconveniences can be avoided with smart contracts, a blockchain application that automates the enforcement of contractual terms such as payments. Similarly, blockchains are a natural choice for notaries to create immutable, publicly accessible property registers —a solution that is already being implemented in the Netherlands. Another example is the growing importance of cyber security. Especially in critical IT infrastructures, it can be worthwhile to use a blockchain solution instead of vulnerable servers to prevent manipulation and to avoid costly disturbances. Finally, blockchains can make supply chains more efficient and transparent by providing a central repository for all important documents, records, and data related to shipping and logistics information. All partners involved can obtain real-time insights into the entire supply chain and thus optimize their processes.

Of course, all that glitters is not gold, and blockchains pose a number of new challenges that we will discuss in detail in the following sections. Although blockchains simplify many aspects of transactions, managers should be aware of some of the key issues that typically occur in blockchain contexts. Such issues emerge in the contexts of formulating rules for participation, establishing governance bodies, making technology decisions, and considering various legal issues (Ziolkowski, Miscione, & Schwabe, 2020). We do not seek to present blockchains as a silver bullet that solves all the governance problems in a transaction; rather, our aim is to weigh some of the practical benefits of blockchains against their inherent limitations.

How Blockchains Govern Interorganizational Relationships

In general, blockchains can perform three eminent and vital governance functions in interorganizational relationships: coordination, safeguarding, and contingency planning (Schepker, Oh, Martynov, & Poppo, 2014). Each of these three governance elements is an important pillar that supports cooperative behavior. Research has shown that inter-organizational relationships that take into account and cater to each dimension at the beginning of such relationships are more likely to succeed as misunderstandings are less likely to arise, the risk of opportunistic behavior is reduced and the partners are able to react to changing circumstances in a coordinated and planned manner (e.g., Hoetker & Mellewigt, 2009; Mellewigt, Hoetker, & Lütkewitte, 2018). Thus, it is important to understand how blockchains can contribute to, and potentially improve, the governance of interorganizational relationships to support positive exchange.

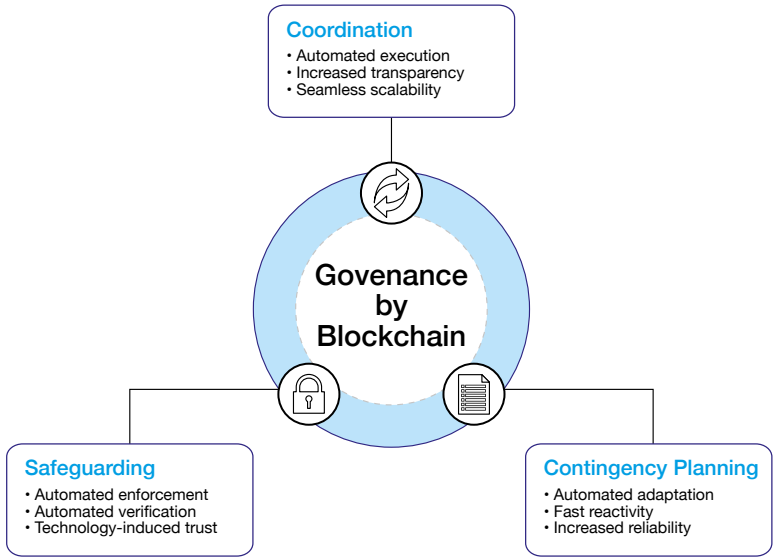


Figure 2. How blockchains govern interorganizational relationships

Coordination through Blockchains

The first critical point in interorganizational governance is coordination. Knowing which party is responsible for which task is essential for the smooth flow of operations. Unlike traditional governance mechanisms such as contracts, blockchains require the business partners to more explicitly specify tasks upfront and formalize the necessary protocols. Although the effort may seem strenuous and costly at first, it provides considerable clarity about each party's responsibilities. Moreover, blockchains make it possible to coordinate complex tasks that would otherwise be impossible to accomplish using a contract. For instance, blockchains are not limited to a certain number of participants but can be scaled up indefinitely once the general participation rules have been defined and agreed upon. Therefore, adding a new supplier to an existing blockchain is relatively seamless and does not require lengthy and costly contract negotiations. In the long run, and with a growing number of participants, blockchains tend to be more cost-efficient than contracts because they are easily scalable. Another advantage is that protocols are automatically executed through a blockchain. For example, once a certain good has been delivered, the blockchain automatically initiates the payment transfer. This automated execution of tasks reduces the need for human intervention and the risk of errors, thus saving on coordination costs.

Safeguarding through Blockchains

The second governance issue pertains to safeguards. Protecting the parties involved in a transaction against opportunistic behavior is important in contexts where parties make relationship- specific investments or exchange sensitive knowledge (Devarakonda & Reuer, 2018; Williamson, 1991). Traditionally, contractual breaches must be prosecuted through the courts, which is time consuming and costly. Especially in countries with weak institutions and rudimentary legal systems, companies may be reluctant to invest in and conduct business because they fear that they will be unable to enforce contractual terms (Zhou & Poppo, 2010). In theory, blockchains can help to overcome this problem and offer a promising alternative. Given their standardized protocols and decentralized architecture, blockchains offer the possibility to automate verification and enforcement without the intervention of a third party. In this manner, blockchains allow companies to monitor transactions in real-time and punish misconduct and violations through automated protocols that are enforced algorithmically. For example, the German carmaker Daimler recently announced a blockchain prototype to enforce its suppliers' contractual obligations, especially with regard to sustainability and ethical compliance (Ledger Insights, 2020b). More generally, blockchains hold the potential to expand transactions to areas that were previously impossible due to a lack of trust in transaction partners or institutions such as collaborations among competitors or investments in countries with weak institutions.

Contingency Planning through Blockchains

The third governance domain relates to contingency planning. In the course of a transaction, market conditions and other relevant transaction terms may change, requiring an adjustment of the relationship (Mayer & Bercovitz, 2008). Contracts are generally relatively rigid and require costly renegotiations in case partners want to change the terms of the agreement (Susarla, 2012). By contrast, blockchains can automate such adaptations since they can process real-time changes algorithmically. For example, parties can agree to flexibly adjust prices based on inflation rates or demand patterns and let the blockchain implement those changes automatically, which facilitates the continuous adjustment process in a relationship. The dynamic integration of contingent factors makes blockchains highly efficient in fast-paced environments such as trading. The automated update protocols that are possible via blockchains make them more flexible and more widely applicable in a context where critical transactional attributes change frequently and predictably. Last but not least, blockchains offer a high reliability and resilience against disturbances, since the data is stored and replicated in a decentralized way.

New Governance Issues Raised through Blockchains

Despite these benefits, blockchains are not without limitations. Especially in public blockchains, which do not set bounds on who can participate, blockchains can lay the ground for criminal activity as there is no central authority to exclude or sanction the participants (Foley, Karlsen, & Putniņš, 2019). In the business context, we therefore often see permissioned blockchains or, more recently, additional layers offering permissioned blockchain attributes atop public networks. This, of course, undermines the very idea of blockchains—a decentralized and authority-free space—and raises questions about market power and dominance and the imposition of rules over others. Another critical issue is data exchange. Since the information in a blockchain is stored in a distributed manner, every user can generally access the data exchanged via the blockchain. In a blockchain for supply chain management, for example, all participants would receive information about delivery times, quantities, prices, and customers. This raises serious questions about data privacy, illegal collusion, and the revealing of valuable competitive information. Managers should be aware these issues and define the scope of their blockchain accordingly to account for these problems, e.g., by excluding certain information such as prices from entering the blockchain (Argyres, Bercovitz, & Zanarone, 2020; Khanna, 1998). This decision may involve a strategic trade-off between increasing the scope to enhance the utility of the blockchain and reducing the scope to protect individual interests. Finally, blockchains may be capable of adapting to foreseeable changes; however, they may be rather inflexible with regard to unpredictable events and major changes that question the entire transaction network. The transaction protocols on which blockchains

are based tend to be relatively static and are difficult to adapt. The failed attempts to reform Bitcoin after several scandals is a typical example of the rigidity of a blockchain network once the rules have been established (Houben & Snyers, 2018). In the following section, we will take a closer look at some more specific caveats of which managers should be aware in the business context.

What Managers Should Consider When Implementing Blockchain Technologies

Blockchains have recently become the focus of managerial discussions on the future of business innovation. Undeniably, there has been some market pressure for companies in various industries to invest in blockchain technologies—at least on an experimental level—and to become familiar with their decentralized concept. However, the fear of missing out might prompt managers to make hasty decisions, with potentially undesirable consequences in the future. For instance, the looming threat of remaining inactive and being overtaken by competitors or missing opportunities to create synergies may lead to rash decisions such as joining existing blockchain networks that are unrelated to a core business, which may not yield the expected benefits in the future and/or establishing new blockchain networks that involve the wrong participants.

In considering blockchain options, it is crucial for managers to assess when and why blockchains are the best available technology to address their current needs. For example, if trust is already assured by other means or the use case is already supported by an existing efficient process, blockchains may add little additional value. In contrast, blockchains are particularly suitable for transactions where the following properties are important:

1. Trust and transparency: Elimination of information silos, reduction of asymmetric information;
2. Tracking and traceability: Tamper-proof evidence for the provenance of a product or service;
3. Efficiency and optimization: Reduction of coordination efforts in transactions involving many parties;
4. Security and risk mitigation: Acceleration of data exchange in security-sensitive environments;
5. Decentralization and immutability: Delegation of control from a central (trusted) authority to a network of peers.

Notably, many blockchain technologies are still in an early stage and can therefore involve high learning and setup costs (Iansiti & Lakhani, 2017). For this reason, a blockchain solution should ideally address several of the above problems to make the investment worthwhile. For example, if a process can be made more secure, transparent, and efficient by using blockchains as opposed to an alternative solution, it is worth considering the investment. However, there is little benefit in jumping on the blockchain train without a clear purpose and awareness of the expected benefits. In the end, managers should weigh the use of blockchain technologies against alternative solutions and develop a thorough business case that weighs the expected (long-term) costs and benefits of the available alternatives. To support this complex decision-making process, we will discuss some of the key questions that managers need to answer before investing in blockchain technologies, which are summarized graphically in Figure 3.

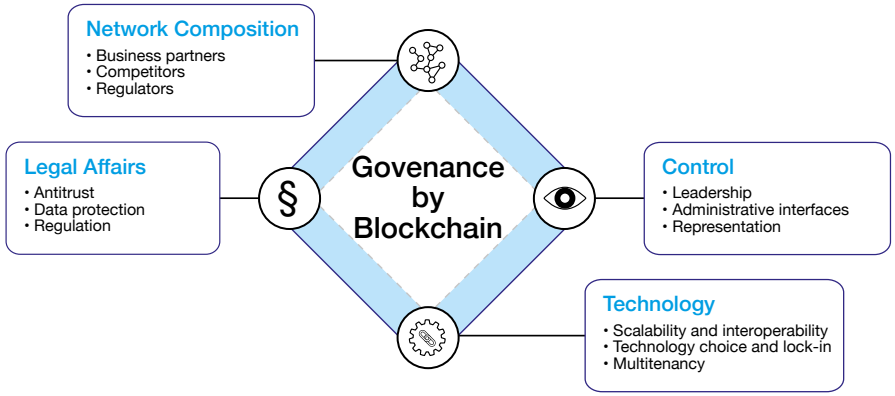


Figure 3. What managers should consider when implementing blockchains

Network Composition: Who Should Be Involved?

In many business contexts, to create value, a company interacts with a range of business partners such as suppliers, customers, alliance partners, competitors, and government agencies. Through their decentralized network structure, blockchains represent an attractive medium to connect multiple stakeholders. A critical question in this context is which actors can and should be involved in a blockchain network and which actors are deliberately excluded. In principle, the benefits of a blockchain network increase with the number of actors; however, at the same time, additional actors may lead to more conflicts of interest. In weighing this participation decision, managers often need to balance three groups of potentially conflicting stakeholders: business partners, competitors, and regulators.

Business Partners.
When a company decides to set up a blockchain network, it often makes sense to involve the firm's business partners such as suppliers, complementors, and alliance partners. These business partners usually have an existing relationship with the focal firm and therefore have a shared interest in maintaining and developing the relationship. Walmart, for example, launched its Food Trust Blockchain initiative by focusing primarily on its existing business partners that were already involved in Walmart's value-creation processes (The Linux Foundation, 2019b). A blockchain network can enhance transparency and trust among participants and thus strengthen existing ties. However, involving many business partners can also create a critical tension when some partners compete with each other and may therefore be reluctant to join the same network. For example, if two of Walmart's suppliers are competitors, they may be reluctant to share volume and price information via the blockchain with their competitors and thus refuse to join the network. For this reason, when considering these competitive dynamics, managers may need to establish protocols that prevent hostile conditions within the network that would preclude business partners from contributing.

Competitors.
The decision to integrate competitors into a blockchain network is of particular sensitivity. On the one hand, competitors can significantly increase the value and acceptance of a network. For example, suppliers in the automotive industry usually have several customers and therefore have a justified interest in serving all original equipment manufacturers via the same network. On the other hand, the nature of blockchains means that sensitive data such as order volumes or prices may be passed on indirectly to competitors. Thus, there is a trade-off for managers between the adoption and diffusion of the network and the control of information flows.

Market power consideration can play another important role in the decision to integrate competitors. Obviously, in most cases, the involvement of large organizations or institutions has a decisive influence on the visibility, acceptance, and success of a blockchain network. Paradoxically, such dominant actors are often indispensable in creating a generally accepted platform and attracting a large number of stakeholders despite the fact that blockchains were originally developed with the aim of decentralization and a reduction of power dynamics. In business contexts, large companies can provide the necessary momentum and financial resources to secure the development and adoption of a blockchain network. The challenge is that large organizations usually have complex internal procedures for decision-making or may give higher priority to other projects. In addition, they may be reluctant to share information with competitors and are less willing to consent to compromises to overcome conflicts of interest. Especially when two similarly large and resourceful companies come together in a network, power struggles can lead to a certain paralysis in their cooperation. However, these potential conflicts are not necessarily destructive and can be used to create a stronger, more defensible, and more inclusive value proposition for all participants.

Regulators.
In some cases, it may be useful to consider involving government agencies or regulators in blockchain projects to ensure the acceptance and legitimacy of the network. The central task of regulators is to ensure a fair and level playing field. By involving regulators, network initiators can establish an unbiased network, overcome reservations among participants, and bring together actors from the whole industry. Especially in highly regulated industries such as finance, aviation, or drug development, it can be of central importance that regulators are on board to ensure compliance. In the financial sector, for example, central banks are beginning to use blockchain technologies to improve existing interbank clearing processes and complement their traditional real-time gross settlement (RTGS) systems with more efficient blockchain-based technologies. Similarly, in the energy market, blockchains can facilitate the energy exchange of prosumers who may have solar panels and electric vehicles. Overall, blockchain networks represent an attractive technology to decentralize high-volume transactions at the national and international levels. In the case of international cooperation, it may be wise to involve the regulatory authorities of different countries. To maintain the neutrality of such authorities, it may be necessary that they do not act as active members of the blockchain but instead function as passive observers who can view the transactions within the network but cannot change them. In doing so, participants also avoid a situation in which regulators assume central or dominant control of the network.

Control: Who Is in Charge of Strategic Decisions?

Leadership.
Despite the promise of decentralization, blockchains may still require certain leadership decisions, especially in regard to governing participation. Many well-known blockchain projects such as Bitcoin or Ethereum rely on permission-less blockchain technologies (i.e., networks without a central authority), which do not require any leadership decisions. By contrast, most corporate blockchains rely on permission-based blockchain technologies (i.e., networks with a central authority) in which access to the blockchain is controlled by a specific actor or committee. For permission-based blockchains, the challenge is to define the leadership of the blockchain project clearly and transparently to guarantee trust in the overall blockchain network. This implies that the leadership of a blockchain network

should be supported by all its members and that this privileged role is not be exploited to serve selfish goals, which can be accomplished with the creation of a strong system of control and balance. For blockchain initiators and sponsors, it can prove beneficial to share their initial leadership position and invite financially weaker, less central players, or neutral regulators to join the leadership team to maintain trust in the network.

Administrative Interfaces.
To facilitate the establishment of a blockchain network and to define the rules of participation, a dedicated administrative interface such as a steering committee, consortium, or joint venture can be formed whereby potential participants can discuss the requirements for a blockchain. Through these formal governance mechanisms, future participants can standardize processes, appoint, and empower representatives, make joint decisions, and resolve conflicts. Moreover, participants can exchange opinions on and agree upon the technical design, the preferred technology, and relevant features to be implemented. Common discussion topics include mechanisms to ensure the integrity of the shared ledger without sharing private information with participants who do not need to know about it and the fair distribution of costs and benefits. The committee can also assist in defining functional requirements and estimating the expected costs and benefits. For example, when Facebook initiated its blockchain-based currency Libra, it formed a consortium of stakeholders including credit card companies, banks, and internet platforms to ensure that the interests of central stakeholders would be considered in the initial stages (Libra Association Members, 2019).

Representation.
To achieve adequate and fair representation of the participating organizations, a set of rules, responsibilities, and expectations must be established a priori. For instance, a crucial decision to be discussed before the blockchain can be launched is the definition of rules for joining and leaving the blockchain. In these constitutive management bodies, co-founders, dominant sponsors, or participants who support a project from the onset typically have a stronger voice than participants who join later. However, there are exceptions to this rule, for example, when an actor joins that is central to the viability of a network or when members are concerned that too much power is concentrated on one single actor. In addition to active voting members, it may also be useful to include observers and nonvoting members in such management bodies to ensure a diversity of opinions and to take into account different interest groups that may be directly or indirectly affected by a blockchain ranging from lobby groups to end users. For example, a blockchain focused on supply chain management could include raw material suppliers, trade unions, environmental protection organizations, and end customers to ensure an adequate representation of stakeholders.

As an alternative to creating a new governance body, blockchain initiators can also integrate the blockchain governance into an existing structure representing relevant stakeholders such as an industry association. This can reduce legitimacy concerns and formation costs while improving information flows and participation rates.

Technology: Which Technical Aspects Should Managers Consider?

Blockchain is a new technology for many organizations, which means that decision-makers may lack experience and knowledge about technical features and requirements. To allow flexibility in change requests while the learning curve for those involved is quite steep, the network structure should be modular and easy to maintain. In addition, a list of expected artifacts, milestones, and a project schedule can be useful to set clear expectations and define goals. For example, major milestones can include a proof of concept, a minimum viable product, and the launch of a blockchain network. The formulation of these milestones largely depends on available technologies, budgets, regulatory constraints, and the urgency of implementing a solution.

Scalability and Interoperability.
Already in the beginning of a blockchain project, it is important to keep the long-term strategic goals in mind to avoid costly adjustments ex post. The scalability and interoperability of the blockchain in particular are key aspects in this calculus. In this regard, managers should have a clear technological strategy for dealing with increasing network size, which may involve adjusting the network size (e.g., the number of copies and nodes) in the distributed ledger. In addition, the choice of technology should allow a seamless integration of new participants and a smooth integration into the existing infrastructure. This issue becomes salient in interorganizational settings where organizations may rely on different IT infrastructures such as their enterprise resource planning software that needs to be partially integrated into the blockchain network.

Technology Choice and Lock-in.
Since the advent of Bitcoin, a variety of distributed ledger technologies (DLTs) have emerged. In corporate networks, Hyperledger Fabric, R3 Corda, Amazon QLDB, and Ethereum Mainnet are currently among the most popular technologies. Each of these technologies differs in its architecture and flexibility with regard to the degree of decentralization and the processes for storing new information in the ledger. Importantly, when choosing a blockchain technology, managers need to be cautious about the type the of software license upon which they agree because license restrictions can lead to an unexpected and undesirable lock-in on a particular platform with considerable follow-on costs and high dependence of a given service provider. For example, a development team might use a

custom boilerplate to speed up the development process by using existing modular software; however, the source code may not be available to other teams at a later date. This does not mean that open-source offerings are always the best solution because implementation and support may be tied to equally restrictive licenses (and fees) in commercial settings. In fact, there is a growing trend to offer ready-made modules or services to accelerate development and thus deployment.

Since there is no one-size-fits-all technology, managers should weigh the benefits and costs of each solution for the specific purpose and potentially combine different technological offerings. Managers should also note that blockchain is still a young technology and new technologies emerge at a rapid pace from university labs and professional service providers alike. Most importantly, many technologies are still at an experimental stage with varying degrees of maturity, meaning that their scalability, modularity and security are often not tested fully. Hence, managers should carefully screen available technologies and seek consulting services from leading industry players.

Multitenancy.
A final consideration relates to the network structure. Distributed ledger technologies offer a wide range of decentralization options, including multitenancy. Multitenancy means that a blockchain node is used by multiple participants. This option to share access to the blockchain can reduce the operational and infrastructure costs of the blockchain but obviously restricts the discretion of participants to engage in transactions as they potentially depend of the consent of another participant that shares the same node.

Legal Affairs: Which Legal Problems May Arise?

Antitrust.
When implementing blockchain solutions, various legal problems can arise of which managers must be aware. A particularly important point is antitrust regulations. Due to the high transparency of information in blockchain networks, competitors may easily compare prices and thus quickly come under suspicion of illegal collusion. This is not only a concern for large corporations but also for smaller firms that operate in niche markets with few players as is often the case with high-technology firms. To avoid this problem, blockchain participants must ensure that competitive dynamics are not jeopardized by the exchange of information via the network. Relatedly, large blockchain networks can contribute to a concentration of market power and a critical monopoly formation. Again, managers can ensure that competition is not illegally inhibited through restriction of blockchain access.

Data Protection.
Another key issue is compliance with data protection regulations. Especially when individual data are stored in blockchains, this can quickly lead to conflicts with legal regulations. The European Union's General Data Protection Regulation (GDPR) law gives citizens control over their personal data whereby an EU citizen can decide to have their information deleted from a database. However, if such data are stored in a blockchain, the immutability of the ledger could make deletion technically impossible and thus be in direct conflict with the law. Apart from GDPR compliance, there may be national or organizational guidelines that must be followed. For example, it may be that company data must remain within a certain country (e.g., Switzerland) or a larger region (e.g., the EU). Data hosting could therefore be limited to certain locations. A wise use of on-chain and off-chain information storage can be a possible solution to take advantage of the benefits of blockchains while being compliant with current legislations.

Regulation.
A third important point is industry regulation. This is especially true for industries that are under strong national or international oversight such as finance, aviation, and drug development. This regulation can vary from country to country, which can make it difficult to organize blockchain networks across countries or industries. The potential consequences of emerging legal issues range from additional delays to costly readjustments to national legislation. For example, regulations in some industries (e.g., banking) require special security requirements to obtain a license. Another example is the obligation to disclose company information in different countries such as the Securities and Exchange Commission in the United States. These points should be reviewed by legal experts as early as possible to avoid unpleasant surprises.

Summary and Managerial Recommendations

Blockchains have the potential to improve business transactions by providing new ways of governing transactions. Through their decentralized architecture, blockchains provide a secure, transparent, dynamic, and scalable solution for transactions in environments where a central authority is not trusted, not wanted, or simply not available. Examples are cross-border transactions, the transfer of sensitive know-how, or complex projects involving a large number of loosely associated parties. These promises come with a number of drawbacks including the need to share information with the entire network, the relative rigidity of the blockchain to fundamental changes in the transaction, and the risks associated with investing at an early stage with rapidly evolving technology. The following table compares the advantages and disadvantages that managers should weigh when deciding to implement blockchains in their organizations.

Table 2. Contrasting advantages and disadvantages of blockchains for businesses

Advantages to Blockchain Governance	Disadvantages to Blockchain Governance
- Enables and facilitates complex transactions across organizational boundaries involving many parties	- Requires educational efforts from managers and staff to understand the concept
- Can, in principle, be easily scaled to include more transactions or more participants	- Lacks flexibility in regard to fundamental changes in the transaction
- Provides a high degree of transparency to all authorized participants	- May involve power struggles when defining blockchain rules
- Defines clear tasks and expectations	- Requires highly standardized and codifiable processes
- Offers a high-security, tamper-proof technology to exchange data and conduct business	- Involves high technical setup and maintenance costs
- Allows automatized enforceability of transaction	- Impedes scaling due to data redundancies in the blockchain network, which can reduce performance and increase data storage costs
- Reduces monitoring and compliance costs	- Raises legal issues regarding collusion and private data protection

An important consideration when implementing blockchains is the type of transaction. Blockchains are most effective in situations where processes can be standardized to a high degree, process security is critical to the transaction, and the nature of the transaction is unlikely to change fundamentally. This would apply, for example, to many banking, insurance, and long-term buyer-supplier transactions, which are highly standardized, require a high degree of reliability and transparency, and are unlikely to change fundamentally over a short period of time. Similarly, blockchains can be very effective in highly regulated industries such as financial services, aerospace, and biopharmaceutical drug development where an integration of regulators into the blockchain network increases transparency and trust for regulators while reducing compliance and monitoring costs for firms. In Figure 4, we provide a schematic decision tree based on the arguments we outlined in the chapter, which can help managers decide whether a blockchain technology might be useful for governing their transactions.

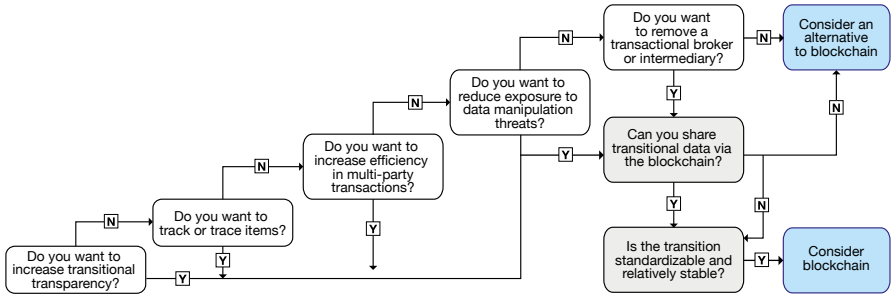


Figure 4. Decision tree to facilitate blockchain implementation decisions

All in all, blockchains offer a largely untapped opportunity for most companies. It is a rapidly evolving technology, and we are likely to see significant progress in the coming years. Recent developments such as the ideas around Web 3.0, the token economy, and the metaverse rely heavily on blockchain technology and are evolving rapidly along with emerging governance solutions such as on-chain voting mechanisms to adapt network rules over time. The promise of blockchain is a more secure, transparent, fast, dynamic, and reliable governance system that can complement centralized server and cloud-based solutions in many ways. As cyber security and data protection are at the top of the radar for many companies as they make the transition to more digital business models, blockchains provide a new technology to realize the full potential of digital transformation (Verhoef et al., 2021). For managers, it is important to understand the benefits but also the limitations of blockchains in a business context. Ultimately, blockchains promise to enable new transactions with novel business opportunities, to turn competition into coopetition or cooperation, and to increase data security. In sum, managers are well advised to explore these possibilities and think about how they can apply blockchains to their business problems.

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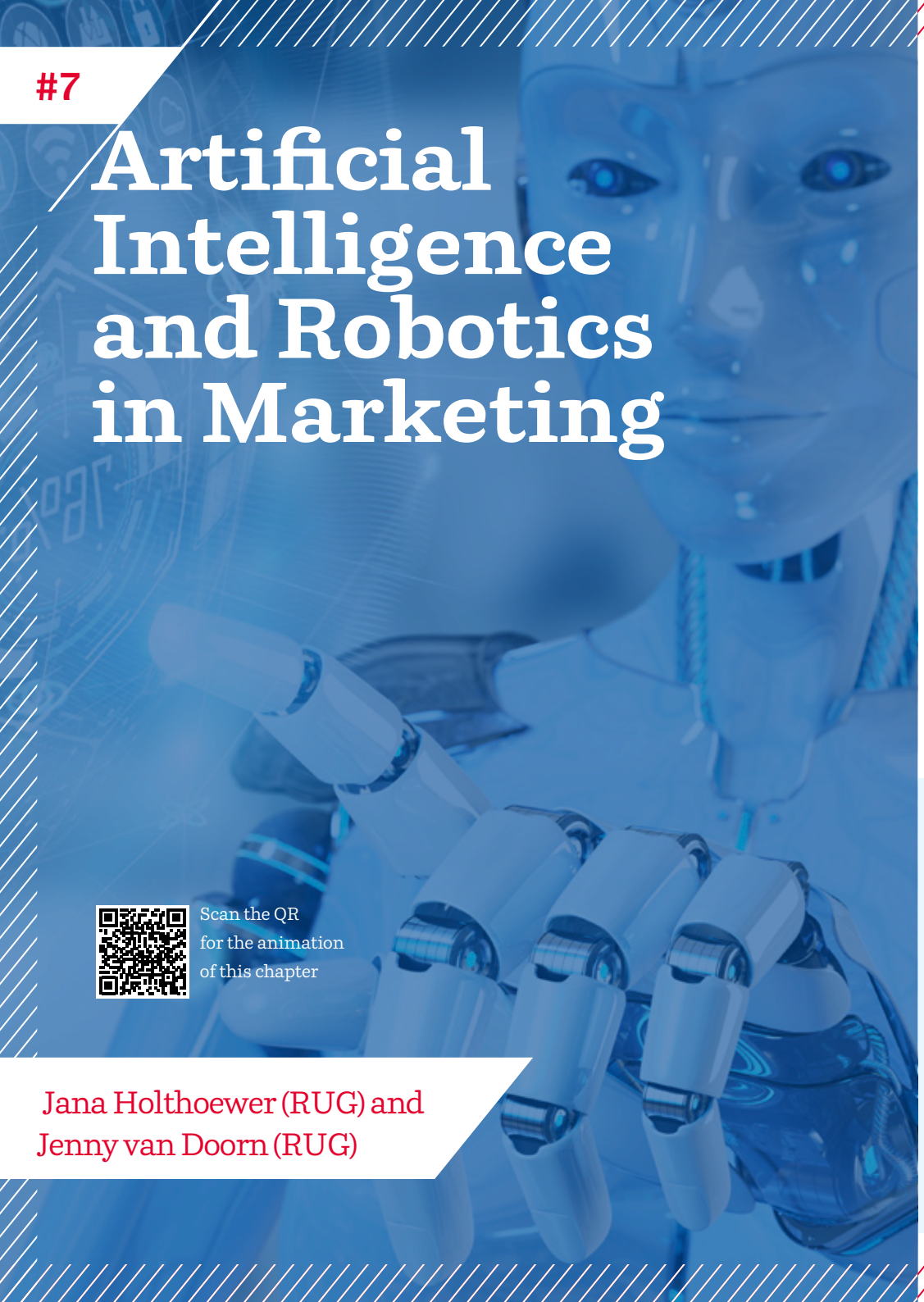
#7

Artificial Intelligence and Robotics in Marketing



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Jana Holthoewer (RUG) and
Jenny van Doorn (RUG)

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This chapter illustrates the role of artificial intelligence (AI) and robotics in marketing and will help managers develop a deeper understanding of its potential to revolutionize the service experience. We summarize the use of AI and robots in practice and show that the adoption of AI predominantly occurs at the task level rather than the job level, implying that AI takes over some tasks that are part of a job and not the entire job.

Based on these insights, we discuss opportunities and drawbacks of AI and robotics and reflect on whether service robots will complement or substitute human employees. Moreover, we explain why many consumers are still reluctant to engage with these new technologies and which conditions should be met in order to benefit from using service robots.

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The Idea in brief

The Issue	The Response	The Bottom Line
What is artificial intelligence (AI), what is a robot and how can they generate value for firms?	AI can correctly interpret external data, learn from it, and apply what it has learned to perform specific tasks. A robot is AI with a physical casing around it. It offers a wide range of potential benefits, including cost reduction, revenue growth, productivity gains, scalability, security, as well as improved customer retention.	Firms need actionable guidance on how, when, and to what extent AI and robots should be adopted. Further, they need to understand consumers' attitudes and behaviors towards it.
How should service robots be deployed and which tasks should they take over?	Robots will not steal jobs in the near future; rather they should take over mundane tasks first because they can deliver services in an efficient, reliable, accurate, convenient and fast way.	A seamless incorporation of robots into the service team and good AI-human collaboration is a must. Robots have the potential to revolutionize the service experience in many industries.

What is artificial intelligence, what are robots?

"California restaurant turns to robot for extra help as it struggles to hire workers", "Robotic technology and AI revitalize the hotel experience", and "Are robots stealing our jobs?" are some examples of the increasing news headlines about the rise of service robots. They highlight that advances in robotics and artificial intelligence (AI) are gaining broad attention across all industries. Given the accelerating adoption of robotic technologies, it is estimated that approximately half of today's work activities could be automated by 2055 (McKinsey Global Institute 2017). While industrial robots are already widely employed in manufacturing and production, robots are increasingly used also in service provision. Worldwide revenue of customer service robots reached US$53.77 million in 2016. The global market for customer service robots is predicted to grow seven times faster than the market of industrial robots (Business Insider 2015), and expected to reach a market value of US$87.97 million by the end of 2022 (Tractica 2017). A robot is defined as "embodied artificial intelligence", i.e., artificial intelligence with a physical casing around it.

Artificial intelligence can correctly interpret external data, learn from it, and apply what it has learned to perform specific tasks in a flexible way. By doing so, artificial intelligence mimics parts of our human intelligence and may perform activities such as learning speech and recognition (Huang and Rust 2018). In customer service, AI can have a virtual presentation, like Apple's virtual assistant Siri or a physical presentation, like the robot Pepper or the C-3PO Star Wars character. A robot as embodied AI can therefore perform both physical and non-physical tasks with a high degree of autonomy and in an environment that is complex (Jörling, Böhm and Paluch 2019).

In addition, robots can either have a humanoid or non-humanoid appearance. On the one extreme, there is the humanoid robot Sophia who looks like a real person and even was offered the citizenship of Saudi Arabia, thus being the first robot to be given legal personhood anywhere in the world. On the other extreme, there are non-humanoid robots like the Roomba vacuum cleaner or the da Vinci Surgical System (Wirtz et al. 2018).

Robotics and AI offer a wide range of potential benefits to organizations and can include cost reduction, enhanced reliability, productivity gains, scalability, improved security and compliance, revenue growth, as well as improved customer retention and improved creativity of managers. Furthermore, the deployment of AI and robots can be a solution in industries that face personnel shortages, such as health care.

The use of AI and robots in practice

Many companies are currently heavily investing in AI. Robotics has the potential to revolutionize customer engagement by transforming the service experience and influencing the extent to which customers intend to use a brand. Chui, Manyika, and Miremadi (2016) stress that although robotics first found its way in industrial manufacturing, its greatest potential lies in customer service. Table 1 summarizes the use of robotics in practice.

Table 1. The use of robotics in practice (Adapted from Mende et al. 2019)

Industry	Example	Scope and investment	Companies using the technology	Robot type
Food Services / Restaurants	"Pepper" waiter taking orders and processing payments		Pizza Hut and Mastercard	Humanoid
	Robot waiter	Restaurants in China	Different restaurants	Humanoid
	"DRU" pizza delivery robot	$17.2 million by Starship Technologies: will roll out in all 12.500 Domino's stores	Domino's	Nonhumanoid
	Bionic bar	$2.2 million	Royal Caribbean	Nonhumanoid
	Robot barista	$5 million	Café X Technologies	Nonhumanoid
	Delivery robot that cooks pizza while driving	$48 million > 1.000 human employees in 2018	Zume Pizza	Nonhumanoid
	Robot waiter serving drinks and entertaining customers	16 robots	Enjoy Budapest Café	Humanoid
	Robo Chef		Moley	Humanoid
Hospitality / Travel	"Pepper" enhances visitors' experiences	Six museums	Smithsonian Institute	Humanoid
	"Pepper" in customer service in train stations and airports	3 train stations in France, Oakland airport	SNCF	Humanoid
	Robotic butler "A.L.O."		Starwood Hotels Aloft	Nonhumanoid
Retail	"Pepper" providing customer service for coffee machines	1.000 Nescafé stores	Nestlé	Humanoid
	LoweBot, OSHBot		Lowe's	Humanoid
	Greeter in shopping mall	2.000 SoftBank shops	SoftBank stores, Mitsukoshi department store, Carrefour	Humanoid
	Hologram robot		Microsoft	Humanoid
	"Tally" monitors product pricing and inventory		Target	Nonhumanoid
	Delivery robots (food, groceries, parcels)	>1,500,000 autonomous deliveries; $85 million	Starship Technologies	Nonhumanoid
	Roomba robot vacuum cleaners	>30 million robots sold	iRobot	Nonhumanoid
Healthcare	"Zora" bot for health and elderly care	Over 400 sold, worth $ million	Hospitals and other healthcare facilities	Humanoid
	DaVinci surgical system	$6.1 million	Cincinnati VA Medical Center	Nonhumanoid
	Rehabilitation robots	$1 billion	Toyota	Nonhumanoid
	"TUG" robots	130 hospitals	Healthcare facilities	Nonhumanoid
	"ElliQ" social companion robot	$14 million by the Toyota Research Institute	Elderly homes	Nonhumanoid
	"Moxi" assisting clinical staff		Hospita or clinical environment	Humanoid
	Companion robot	Used at >80 institutions in US	Hospitals and other healthcare	

Owing to challenges associated with aging populations and an ever-increasing shortage of personnel, the healthcare sector has invested heavily in robots and other technological solutions. This is where the greatest growth in robot deployment in the Netherlands is expected (Rijksdienst voor Ondernemend Nederland 2017). For example, the robot Zora regularly comes into action in different nursing home organizations across the Netherlands, used for pleasure and entertainment or to stimulate the physical activities of clients in residential care (Huisman and Kort 2019).

Next to the healthcare industry, technological advancements can also be found in hospitality. Scholars indicate that 73% of the activities that employees perform in food service and accommodations could be automated (Chui, Manyika, and Miremadi 2016), including preparing and serving food and drinks, cleaning food-preparation areas, and collecting dirty dishes. A restaurant in China has already replaced its waiters with robotic ones, which can take orders, deliver food, and speak to customers in simple Mandarin phrases (Nguyen 2016). Also Starwood Hotels has started to notice the potential of using service robots. The company has launched robotic butlers into their Aloft line to deliver toothbrushes, razors, and similar items to guest rooms (Solomon 2014).

Similar robotic applications can be found in the retail industry, with several companies implementing AI solutions to their stores. For instance, Lowe's introduced an autonomous retail service robot in 11 of its stores throughout San Francisco in 2016. North Face utilizes Watson as its in-store sales assistant that asks customers several questions and then makes a recommendation accordingly. Walmart has announced to deploy robotic floor cleaners, in-store pickup towers, shelf scanners, and truck unloaders across its hundreds of stores in the U.S. for the purpose of cost cutting. Its robotic shopping cart, called Dash, is now in the trial and evaluation period and will enter production soon.

Overall, the accessibility of AI-delivered services gives not only larger but also smaller companies the potential benefit of remarkable economies of scale and scope, given that the majority of costs arise in their development. Although robots or AI systems have its price (e.g., 20.000€ for the humanoid robot Pepper), one should keep in mind the huge scalability. Particularly, virtual AI services such as customer chatbots can be deployed at insignificant incremental cost, scaled at close to zero (Wirtz, Kunz and Paluch 2021). Cost saving is often still the main driver for organizations to deploy robots in their service settings. For instance, customer service costs can be reduced by up to 30% by using chatbots and virtual assistants as conversational solutions (Techlabs 2017).

In other instances, technical solutions have to be considered due to unaffordable human labor costs, which can often be found in healthcare services. For example, a German research team is currently working on a system of smart speakers and home automation solutions that send people with dementia back to bed when they get up at two in the morning and get dressed. Such intensive supervision is nearly impossible with normal human carers, thus, AI might be deployed in a way without unduly compromising patients' care experience (Amiribesheli and Bouchachia 2018).

Furthermore, robot application can have skills that human workers do not have. One large advantage the current generation of robots has is their versatility regarding language.

For instance, the robot FRAnny assists international travelers at Frankfurt Airport and guides customers through their service journey. The robot helps customers in multiple languages and answers questions like flight departure times or the nearest accessible restroom (Frangoul 2019). Also in a health care environment with an increasing inflow of multilingual clients, multilingual robots can be advantageous. With advancing age, people can experience language loss (attrition) and retreat to their first language, which can be a foreign language, but also a regional one. Previous literature indeed shows that a local accent of synthetic voices is more positively viewed than a non-local one (Alamasaputra et al. 2006; Tamagawa et al. 2011).

Developing robots that can also adapt to their user in terms of language is therefore an important avenue for the future. One example is a Pepper robot equipped with a synthetic version of the local "Grunnegs" dialect (https://groningserobot.webhosting.rug.nl/). In a field study where respondents could interact with Pepper speaking the regional language "Grunnegs" or Dutch, researchers found that the regional robot voice is evaluated as better understandable, more natural, and more pleasant than the Dutch robot voice. This higher evaluation leads to higher trust in the robot. Yet, the robot speaking regional language was also perceived as more eerie (van Doorn 2020).

Which tasks can AI and robots perform?

The use of AI and robots predominantly occurs at the task level rather than the job level, implying that AI takes over some tasks that are part of a job and not the entire job. AI taking over tasks has the potential advantage that humans can better focus on and perform in core task, such as building customer relations. Originating from process automation, robots have become highly effective at performing repetitive tasks previously performed by humans, such as carrying objects and undertaking monotonous assembly jobs. Robots are increasingly capable of more sophisticated physical as well as cognitive activities, ranging from offering wealth management advice and identifying spills on a shop floor to detecting worsening dementia. More advanced functions of service robots are employed in professional services, such as financial auditing and assisting in medical procedures through voice-activated robotic arms.

Huang and Rust (2018) classify tasks as requiring different types of intelligence: mechanical, analytical, intuitive, and empathetic. Mechanical intelligence performs repetitive tasks for consistent and reliable performance such as the robot Pepper taking on frontline greeting tasks at a hotel lobby. Learning and adaptation is here at its minimum. Analytical intelligence analyzes and makes decisions rationally, which involves learning and adapting systematically based on specific, non-contextual data. An example would be Toyota's in-car intelligent system that replace problem diagnose tasks for technicians. Intuitive intelligence analyzes and makes decisions intuitively, which implies learning and adapting based on understanding and richer contextual data. For instance, an American news agency company announced in 2016 that Minor League Baseball games are now being covered by robot reporters. As such, they were upping its narrative sports reporting game by letting robots generate recaps.
Lastly, empathetic intelligence has the capability to recognize, emulate, and respond appropriately to human emotions. Take the chatbot companion Replika, designed for anyone who wants a friend with no drama or judgment involved. The AI may counsel someone through insecurities and social anxiety, while being ever-patient and, thus, replacing psychiatrists for psychological comfort. This implicates learning and adapting based on experience.

These tasks are listed in the order of difficulty with which AI masters them (see Figure 1). While mechanical tasks are already taken over by AI – industrial robot or surgical robots for instance –, AI still struggles when taking over tasks that require higher intelligences. AI applications for analytical tasks can also increasingly be found, such as IBM's Watson in Accounting or self-driving car systems. Jobs that are comprised of tasks requiring different intelligences will be the best candidates for human–machine integration. A full overview is given in Table 2 by Huang and Rust (2018).

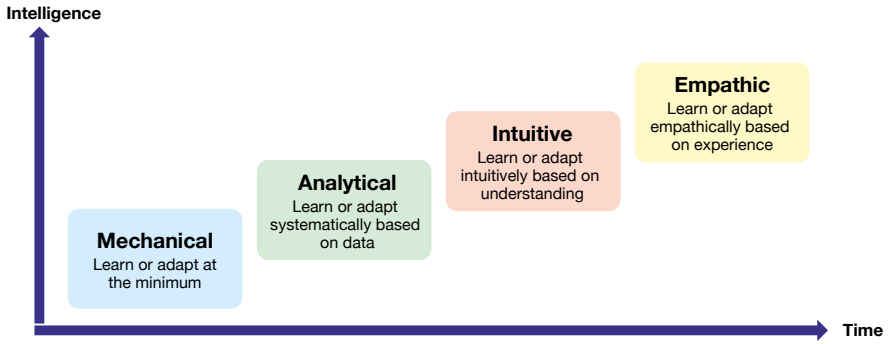


Figure 1. The four intelligences (huang and rust 2018)

Table 2. Intelligences, Nature of Tasks, Job Replacement, and Service Implications (Huang and Rust 2018)

Intelligences			Job Replacement
AI	**Skill / Labor**	**Nature of Tasks**	**AI Applications**
Mechanical			
• Minimal degree of learning or adaptation • Precise, consistent, and efficient • For example, self- service technologies and service robots • Rely on observations to act and react repetitively	• Skills that require limited training or education • Call center agents, retail salespersons, waiters / waitress, and taxi drivers	• Simple, repetitive, standardized, routine, and transactional tasks • Tasks require consistency • Commodity service	• McDonald's "Create Your Taste" touch screen kiosks • Robot Pepper takes on frontline greeting tasks • Virtual bots turn customer service into self-service
Analytical			
• Learns and adapts systematically based on data • Logical, analytical, and rule-based learning • For example, IBM's chess player Deep Blue • Rational decision-making	• Technical skills requiring training and expertise on data and analysis • Technology-related workers, data scientists, accountants, financial analyst, auto service technicians and engineers	• Analytical, rule-based, systematic complex tasks • Tasks require logical thinking in decision-making • Information, data and knowledge-based service	• Toyota's in-car intelligent systems replace problem diagnose tasks for technicians • IBM's Watson helps H&R Block for tax preparation • Penske's onboard technology takes over navigation tasks
Intuitive			
• Learns and adapts intuitively based on understanding • Artificial neural networks-based or statistical-based deep learning • For example, Watson's Jeopardy, Google's DeepMind AlphaGo and AI poker player Libratus • Boundedly rational decision-making	• Hard thinking professionals that require creative thinking for problem-solving skills • Marketing managers, management consultants, lawyers, doctors, sales managers, and senior travel agents	• Complex, chaotic and idiosyncratic tasks • Tasks require intuitive, holistic, experiential and contextual interaction, and thinking • Personalized, idiosyncratic, experience- and context-based service	• Associated Press's robot reporters take on the reporting task for Minor League Baseball games • Artificial intuition takes on the data interpretation task in Gestalt psychology • Narrative Science's AI Quill writes as if human authors
Empathetic			
• Learns and adapts empathetically based on experience • Emotion recognition, affective computing, and communication style learning • For example, Hanson's Sophia and chatbot Replika • Decision-making incorporates emotions	• Soft empathetic professionals that require social, communication, and relationship building skills • Thinking jobs requiring people skill (e.g., politicians and negotiators) or feeling jobs (e.g., psychiatrists)	• Social, emotional, communicative, and highly interactive service • Tasks that require empathy, emotional labor, or emotional analytics • High-touch service	• Chatbots communicate with customers and learn from it • Replika replaces psychiatrists for psychological comfort • Sophia robots interact with customers as if employees

Service robots are generally expected to take over the routine tasks from employees. For example, robots can outperform humans in data gathering and analysis, in handling generic customer inquiries and generally, in executing tasks that are typically repetitive, common and structured, with little to no differentiation. Service robots have the ability to deliver services in an efficient, reliable, accurate, convenient and fast way. Overall, service robots are expected to deliver services that fulfill either primarily functional needs (e.g., ticketing services). The Service Robot Deployment model states that service robots could take over service tasks with nearly any degree of cognitive almost all tasks with low social/emotional complexity (Wirtz et al. 2018; Paluch, Wirtz and Kunz 2020). Yet, service tasks that require high social/emotional complexity mostly have to be performed by employees given that service robots are not be able to engage in deep emotional acting in the near future. Since robots are controlled by algorithms and have no inner emotions, they are not a great fit for services that require empathy and uniqueness (e.g., intuitive and empathic intelligences). These service tasks should still be performed by human employees who can bring genuine emotions like excitement, compassion or joy to the service encounter.

AI and robots with a social function: Automated Social Presence

An important question is how the current generation of automation (e.g., AI and robots) differs from previous generations of automation (e.g., cash machines). What makes AI and robotics fundamentally different? The answer is that these new technologies engage their users on a social level, thus, one interacts with the robot in much the same way as with service employees. Previous literature has coined the novel term "automated social presence" to denote that AI and robots distinguish themselves from traditional self-service technologies by "the extent to which technology makes customers feel the presence of another social entity" (Van Doorn et al. 2017, p.43).

Current and emerging AI technology can consist of different combinations of automated and human social presence. Figure 2 summarizes these different combinations, distinguishing between services with high and low human and high and low automated social presence (van Doorn et al. 2017). Overall, in quadrants 1 and 2, AI has no or low social presence and only performs tasks that require analytical and mechanical intelligence. In quadrants 3 and 4, AI has higher social presence and also performs tasks that require intuitive and empathetic intelligence.

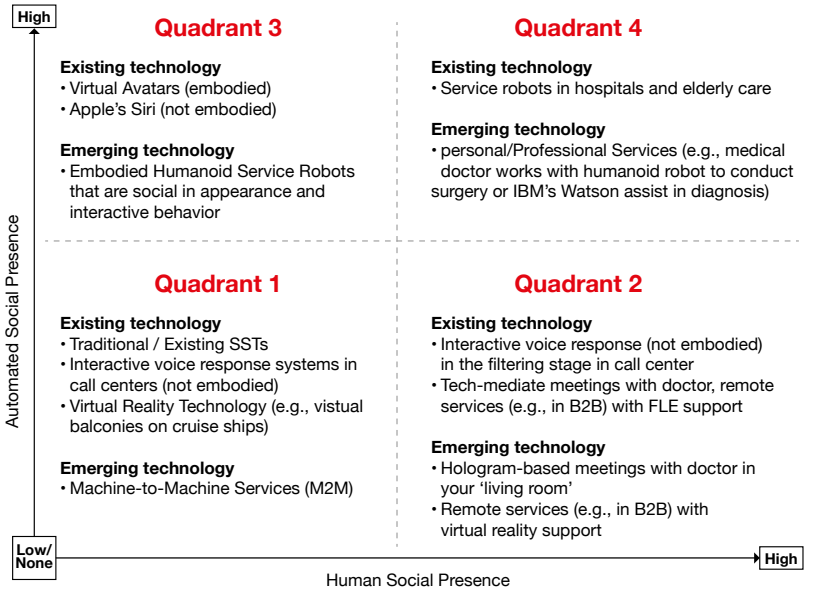


Figure 2. A typology of technology infusions into customers' service frontline experiences (Van Doorn et al. 2017)

Low automated social presence and low human social presence (Quadrant 1)

Quadrant 1 includes services without any social element that are already largely automated, such as the automated teller machine (ATM). Further developments are expected by machine-to-machine communication and the so-called Internet of Things, as a result of which more and more everyday objects have sensors and are connected to the Internet, such as a smart thermostat.

Low automated social presence and high human social presence (Quadrant 2)

In quadrant 2 the focus is on human social presence, and technology is a tool to transport it (e.g., telepresence robots). This kind of robot is already regularly used not only in healthcare, but also for meetings and conferences. Hologram technology is also increasingly seen as a possible alternative when people cannot travel due to restrictions such as recently under the COVID-19 pandemic, or strive to reduce their travels to save time, or CO2 emissions.

High automated social presence and low human social presence (Quadrant 3)

To facilitate robot–customer service interactions, firms often prefer human-like service robots to increase a customer's perception of social presence. These robots show human characteristics, have a human shape, or mimic human behavior. There are already some humanoid robots in practice, such the waiter "Pepper" who takes orders and processes payments for Pizza Hut in cooperation with Master Cards in Japan. Another example is the Furhat robot calles FRAnny that speaks 40 languages and has been used in Frankfurt airport as a multilingual concierge, helping travelers find their way (Frangoul 2019).

High automated social presence and high human social presence (Quadrant 4)

Next to replacing human workers with AI, there is also the possibility of AI-human collaboration. Ivy is an automated virtual concierge based on IBM Watson and is implemented by Caesar's Palace and responds to guest requests. When Ivy cannot provide a confident response, a human front desk agent will be prompted to address requests or inquiries. According to Caesar's Palace, the average resolution time for manual guest text messages has been reduced to less than one minute. Another practical example is Humana, an U.S. based healthcare company that utilizes AI software trained to detect conversational cues to coach their call center agents and supervisors. The digital coach Cogito Dialog alerts call center agents to cues that signal increased agitation, such as a rise in the pitch of a customer's voice. Humana reports an 63% improvement of employee engagement scores and 28% improvement of customer satisfaction. Yet, the customer contact is handled entirely by the human (Nichols 2019).

Regarding the robot-employee working relationship, research has indicated that robots can simultaneously enhance employee satisfaction and productivity. For instance, Noone et al. (2012) suggested that robots could augment employees' cognitive capacity. In a healthcare context, Barrett, Oborn, Orlikowski and Yates (2012) found that the usage of pharmaceutical-dispensing robots in hospitals allows pharmacists more time to engage with and care for their patients.

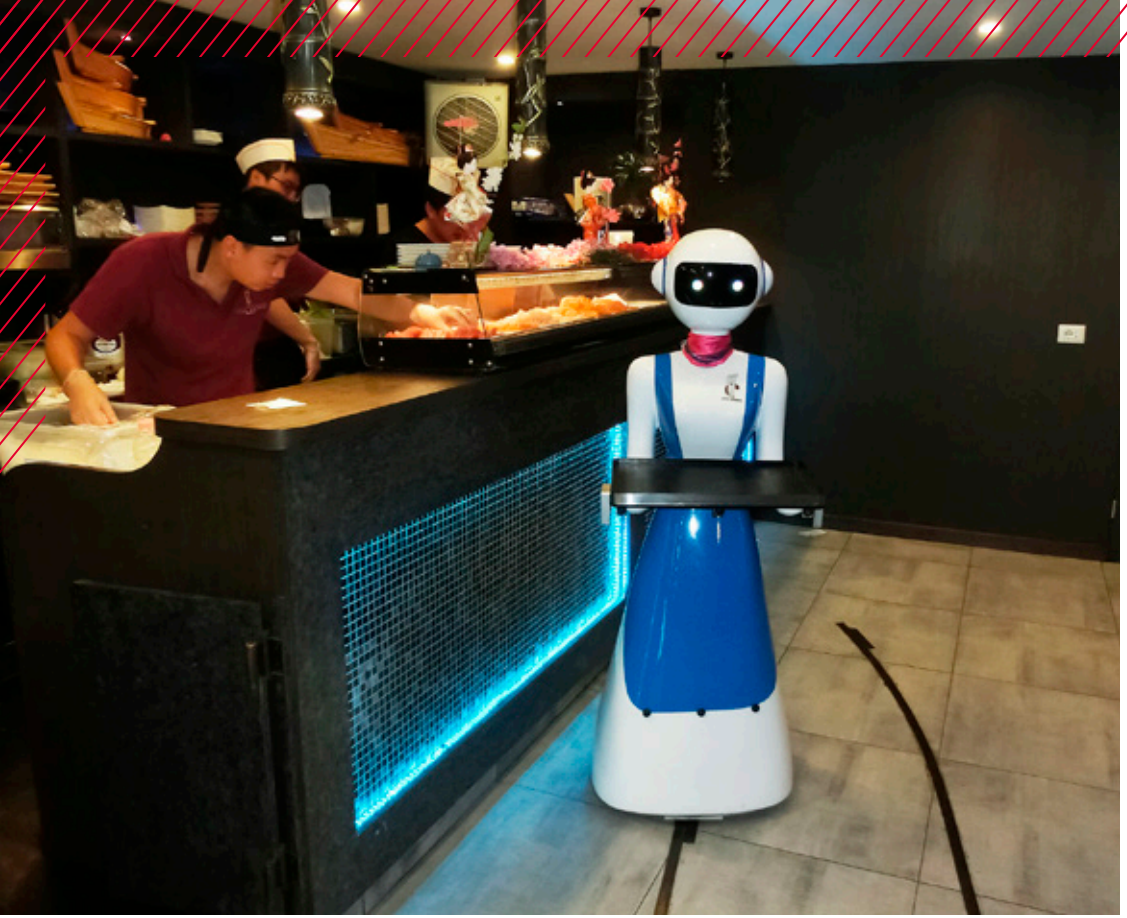
Besides the potential benefits for employees, there is also a potential negative impact of robots on service employees. Service employees may experience perceived loss of autonomy and frustration in their jobs. In a healthcare context, service robots can challenge employees in their task coordination. These together can produce numerous tensions for employees such as feelings of dismemberment and disempowerment, depersonalization (i.e., experience of disengagement and disruption) and clinical voyeurism (i.e., service employees experiencing discomfort when watching their patients through the screen; Green, Hartley and Gillespie 2016). Robotics might also make it more difficult for employees to learn, leading to confusion, lower trust and increased miscommunication (Beane 2019).

Anthropomorphism or humanlikeness of Automated Social Presence

In the virtual context, chatbots' imitation of human behavior can often convince customers that they have been interacting with a real human worker. Novak and Hoffman (2019) note a growing consensus in psychology and marketing that anthropomorphism, or humanlikeness, is imperative for understanding how customers experience inanimate objects. Anthropomorphizing objects means imbuing "the real or imagined behavior of nonhuman agents with human-like characteristics, motivations, intentions, or emotions" (Epley, Waytz and Cacioppo 2007, p.864; Aggarwal and McGill 2007). For instance, the humanoid robot Sophia that has many human-like facial expression is recognized as highly anthropomorphic, whereas the non-humanoid robot vacuum Roomba is seen as much less anthropomorphic. The degree of anthropomorphism is one important element, which is inherently required for a robot's ability to engage in meaningful interactions.

While marketing has found anthropomorphism to increase product and brand liking (Aggarwal and Gill 2012), whether anthropomorphism in service robots enhances customers' experiences is largely unclear. One perception is that consumers respond positively to robots with human-like behavioral characteristics because they can relate easily to them and bond with them (Broadbent et al. 2013), and research results have highlighted the favorable impact of anthropomorphizing service robots on customers' trust, intention to use, and enjoyment (Van Pinxteren et al. 2019).

However, another school of thought cautions that robot anthropomorphism can also backfire, often building on the uncanny valley theory (Mori, MacDorman and Kageki 2012; Mende, Scott, van Doorn, Grewal and Shanks 2019). This theory proposes that with increased human-likeness, the affinity for the robot increases until it closely resembles a human and a strong feeling of uncanniness occurs, resulting in a radical shift from positive to negative responses. The reason for this is that a robot that looks human often cannot live up to the expected human behavior. Accordingly, consumers exhibit greater



avoidance of encounters with highly human-like robots than with those appearing more machine-like because they bring the risk of raising expectations for certain cognitive capabilities which cannot be met by the robot. Discomfort towards a robot can also be explained by evolutionary theory because humans perceive robots as a potentially threatening other species or associate them with diseases. Robots can frighten us into losing control or evoke thoughts about intelligent robots that will rule over humanity. Overall, previous research has yielded mixed findings regarding the role of robot anthropomorphism, indicating positive (Stroessner and Benitez 2019), neutral (Goudey and Bonnin 2016), and negative effects (Broadbent, Jayawardena, Kerse, Stafford and MacDonald 2011). Thus, clear management guidelines are lacking, which is unfortunate given firms' need to "carefully consider how to use AI [artificial intelligence] to engage customers in a more systematic and strategic way" (Huang and Rust 2021, p.3).

Potential adverse reactions to AI and robots

Research on customer acceptance of service robots as physical, embodied AI has suggested that robots can contribute to facilitating and enhancing the customer experience (e.g., speed, convenience and accessibility), while also causing potential negative consequences. Next to the previously discussed importance of the level of anthropomorphism of the AI, scholars have found more critical factors that may cause adverse reactions.

One study has investigated the use of robots in elderly care, in particular how the use of a robot vs. a human coach motivates elderly to participate in exercise games (Čaić, Avelino, Mahr, Odekerken- Schröder and Bernardino 2019). The study also looked at how the robot affects feelings of warmth (being helpful or caring, indicating a positive or negative intent) and competence (being skillful, indicating the ability to effectively pursue the intent). Robot coaches were rated lower in warmth, competence and intentions to use than human coaches. According to another study (Mende et al. 2019), the use of humanoid robots in the restaurant sector triggers negative feelings, such as eeriness and human identity threats. Consumers respond to this threatening stimulus with compensatory behaviors, namely increased consumption of unhealthy food, buying status-signaling products, and seeking social affiliation. The effect of robots on attitudes and consumption can be attenuated by social belongingness (e.g., feeling more connected to other people), healthy food, and machinizing the robot by giving it a technical instead of a human name.

While prior work predominantly shows that consumers prefer human service providers over service robots because robots can trigger negative feelings, some empirical research has also found that consumers are not always reluctant to accept service robots. Accordingly, Merkle (2019) stresses that consumers may evaluate a service robot more favorably than a frontline human service employee after a service failure. In addition, consumers react more positively to robotic service providers if human presence is the source of potential negative feelings (Holthoewer and van Doorn 2021; Pitardi, Wirtz, Paluch and Kunz 2021). This relates to service encounters where human social presence causes apprehension of social judgment, such as when consumers need to acquire embarrassing products, are faced with criticism, or are confronted with their own mistakes. Other research has highlighted that preference for a robot over a human can be task-specific. For instance, older people preferred robotic to human assistance for

some instrumental activities such as housekeeping or setting medication reminders but not for other common daily living tasks, such as shaving, walking, or getting dressed (Smarr et al. 2012).

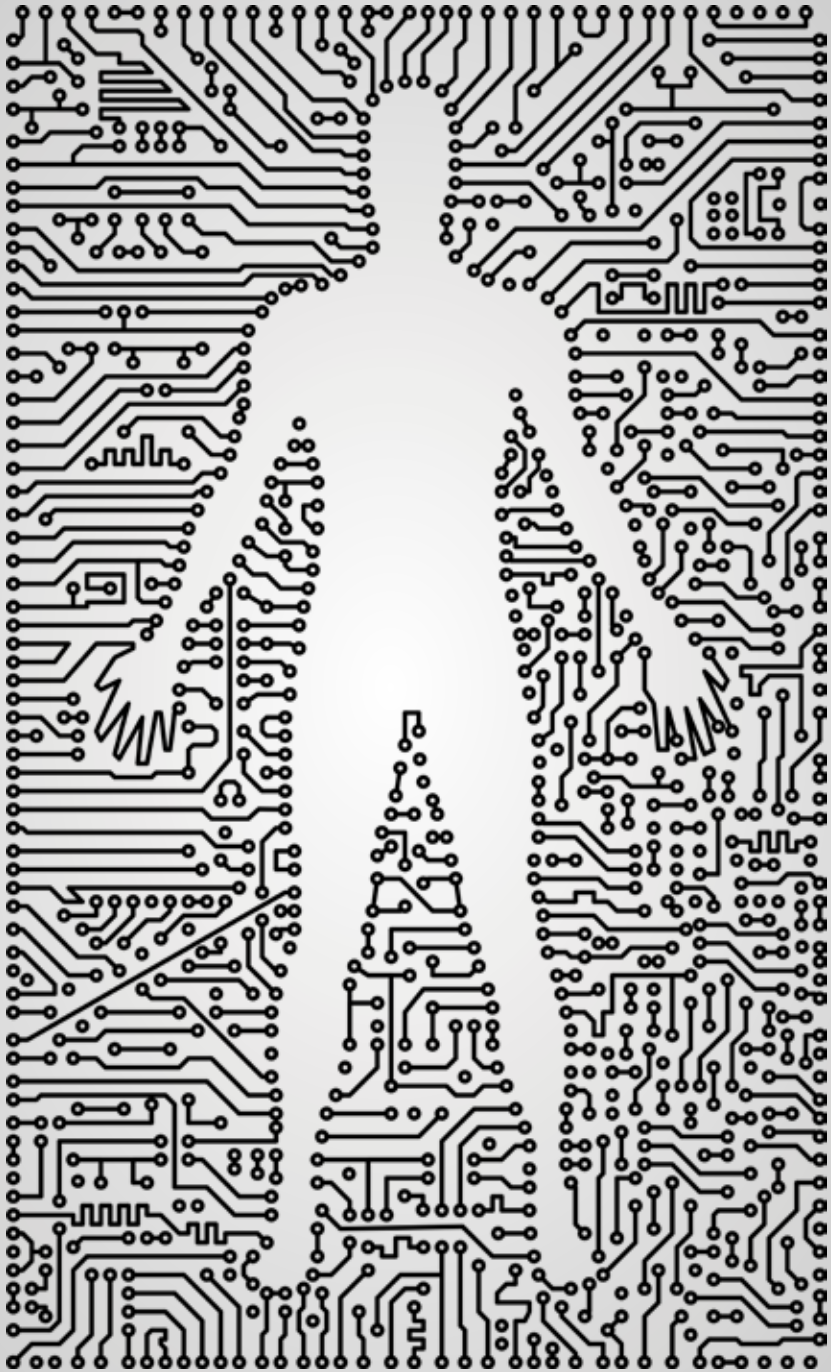
Table 3. Potential negative reactions towards the artificial intelligence, service examples and possible counter measures

Adverse reactions	Service examples	Counter measures
Refusal to accept or comply with the AI / robot	• Robots can be perceived as less warm and competent, lowering behavioral intentions to follow a robot's advice • Customers are not familiar with new technologies and do not know how to use them • The elderly may feel deprived of human contact and usual social networks	• Higher acceptance when the AI speaks the local dialect • Direct speech with polite gestures is an effective way to increase patient compliance • AI should perform routinized, simple tasks and not perform services that require emotions or empathy • Use service robots in settings that might cause judgment, e.g. embarrassing medical examinations
Uncanniness and eeriness, feelings of threat	• The robot is anthropomorphic, i.e. highly human-looking	• Don't make the robot too human-like • Don't give the robot too much autonomy, let the customer have perceived control
Increased discomfort, leading to compensatory behaviors	• Consumers who interact with a service robot rather than a human employee favor purchasing status goods, seek social affiliation, and order and eat more food	• Emphasize that the robot is a machine, e.g. by not giving the robot a name
Misconception, prejudice, and anxiety	• Customers may avert AI-delivered services due a perceived loss of human touch • Consumer privacy issues may arise	• Organizations need to develop a set of guidelines on the responsible use of technology, e.g. in terms of storing data

Will service robots complement or substitute human employees?

Scholars believe that robots will act as a useful complement to the service force, and customers can expect to be served by a combination of a robotic and human workforce in most service encounters over the coming years (Xiao and Kumar 2021; Miremadi, Narayanan, Sellschop and Tilley 2015; Shah 2016). So far, robots are superior only at those simple, routine, repetitive, and algorithm-based tasks that require little creativity, expertise, and social skills but are not suitable for those creative or innovative tasks that require higher order thinking, which are beyond algorithmic enunciation (Miremadi et al. 2015; Nedelesu 2015). Lariviere et al. (2017) highlight two important roles that robots can play in customer- facing service scenarios: (a) augmentation (assisting and complementing human employees) and (b) substitution (replacing human employees). Frontline service robots substituting or replacing employees is perceived as a more innovative move, but frontline service robots augmenting frontline service employees appear better for the ethical/societal reputation of a service provider (McLeay, Osburg, Yoganathan and Patterson 2021). Augmentation of employees may provide a smooth transition for service organizations seeking to introduce frontline service robots, as it is not perceived to be as damaging to the ethical and societal reputation of a brand than substitution. Furthermore, robot may supplement human employees also with skills that are difficult to obtain for human workers, such as speaking many languages. In case robots substitute employees, the company should focus on moving employees replaced by frontline service robots to other roles where robots are unable to perform effectively and ensure customers are made aware of this to reduce reputational damage.

Nonetheless, in a time of service automation, employees can be understandably wary about their jobs as many routine tasks (e.g., those in many standard customer contact center) are likely to be performed by service robots and AI. Given the superiority of service robots in those tasks, scholars have highlighted the need for service employees to advance their skills to either act as managers and caretakers of the robots (Barrett et al. 2012) and/or remain superior in their service delivery capabilities. Beane (2019) highlights the importance for firms to reshape their service roles such that employees are incentivized to learn how to work and collaborate with robots and allow employees to make mistakes in their learning. Furthermore, the redesign of service roles should involve empowering employees to instruct and coach, and building a skill collection including the expertise and tools needed for robot infusion in service roles.



Besides technical expertise, employees also have to develop relevant skills to not only operate robots but also build relationships with relevant stakeholders, thereby protecting themselves from being automated out of their jobs (Fleming 2018). Furthermore, and possibly most important, service employees should distinguish themselves by seeking professional development opportunities to sharpen human capabilities currently under-serviced in education and training. These prized soft skills include emotional intelligence, intuition, and creative thinking, specifically in relation to empathy, persuasion and social understanding (Huang and Rust 2018). Together, these skills allow service employees to focus on "feeling" tasks in order to meet customers' emotional needs (Huang et al. 2019).

Summary and managerial recommendations

With the increasing prevalence of robots in service settings, organizations that want to employ service robots need to understand consumers' attitudes and behaviors towards them. As successfully incorporating robots into customer service is a significant challenge for most organizations, organizations need actionable guidance on how, when, and to what extent service robots should be adopted. One major implication for employees is that robots will not steal jobs from people, but they will definitely change how people work (Muro and Andes 2015). Employees should welcome such change, because the tasks that robots can take from human workers are those mundane and boring predefined tasks with prestated outcomes, in which the engagement and the work productivity of human workers is low anyway (Nedelescu 2015). With robots taking over those less meaningful, dehumanizing, algorithmic tasks, employees can focus on the more creative, innovative, interesting, and valuable tasks (Brooks 2014; Nedelesu 2015). Nevertheless, if AI should take over intuitive or empathic tasks, we recommend to exercise great care. A robot's emotions can only be displayed are therefore not authentic. Depending on the task for the robot to take over, it might not be appropriate to simply show superficial fake emotional responses; rather customers expect that the service provider shows understanding and displays real emotions. Particular attention should also be paid towards the anthropomorphic design of the robot. Managers should avoid the uncanny valley when using AI, for instance by machinizing the technology rather than making it highly human-like.

But, how should robotics be deployed for (frontline) customer service? The answer is absolutely not an easy one. It is much more complicated than purchasing some

machines and getting them to work immediately. As mentioned earlier, robots cannot completely replace human service workers in the foreseeable future. Thus, for a substantial period of time, robots will co-work with human employees in the customer service sector. Therefore, it is very critical to seamlessly incorporate robots into the customer service team and good AI-human collaboration is a must. With smooth and efficient incorporation, companies can achieve an effective service team that utilizes the respective strengths of human employees and service robots when compared to service teams comprised of only human workers and might subsequently outperform them. AI's enormous data and knowledge has immense potential to improve and enhance the customer experience with more personalized products and services.

Overall, AI and robotics have great potential to revolutionize the service experience in many industries, among others healthcare, retail, hospitality and travel, as well as dining services and restaurants. Owing to challenges associated with aging populations and an ever-increasing shortage of personnel, the healthcare sector has invested heavily in service robots. Deploying service robots in hospitals, elderly care facilities or rehabilitation centers have the advantage to reduce the workload of human staff, thereby improving the quality of care and supporting patients. They could perform daily tasks such as physical monitoring, reminding patients to take their medication, conducting physio exercise trainings, playing games, or reducing loneliness of the elderly. Examples are the healthcare robot "Zora" that activates clients in physical exercise classes, or the "Paro" robot that serves as a pet-like companion. "Zorgmaatje" and "Tessa" are robots that can remind clients of medicine intake, and can help to structure the day. Again, it is important to keep in mind that the service robot assists, and not replaces, the human staff. Accordingly, robots functioning as assistive devices may help to bridge the widening gap between the need and supply of healthcare services. This is particularly relevant in healthcare services because replacing carers with service robots would deprive patients of human contact and usual social networks, thereby leading to the dehumanization of care.

Next to the healthcare industry, there are other service environments with robot frontline employees, such as hospitality. As discussed earlier, it is advisable to let robots execute simple, standardized tasks in which the AI will likely to be superior because it can deliver services in a reliable, fast, and efficient way. For instance, the "Pepper" robot greets and serves customers in restaurants, airports, and cruise ships, while always being friendly, attentive, and patient (Blut, Wang, Wünderlich and Brock 2021; Mende et al. 2019). AI taking over such tasks of a job has the potential advantage that humans can better focus on and perform in core tasks, such as building customer relations.

An important implication for businesses that aim to successfully deploy service robots is the amount of investment. This includes acquisitions costs, development of programmers and specialists, as well as building virtual networks and maintenance of systems. Hence, robots should be seen as a long- term investment. In the Netherlands, the company Welbo is an expert in helping their customers with high-quality robotics solutions to improve business processes. The company focuses on three segments – office spaces, municipal counters, and elderly care – and provide solutions for front desk reception, queue management, and gathering feedback. Next to the robot Pepper, the firm also offers a social robot transporter, which is highly configurable to the needs of your company and can service in restaurants, hotels, business offices, airports and more. In particular, the robot may provide customers with whichever item has been ordered through the app (e.g., a cup of coffee). Overall, Welbo emphasizes that service robots should be more seen as possibility to create a business case rather than being an expensive gimmick.

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#8

Digital Twins

An enabler for digital transformation

Scan the QR for the animation of this chapter

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Digital Twins are a virtual representation of anything of value for an organization that create a link between the real and virtual worlds by a continuous bidirectional data/information exchange. In this chapter we present the origins of the concept and how it evolved with the advent of new technological trends. In addition, we describe the main characteristics of a Digital Twin, the benefits of its use, and real-world examples of the usage of digital twins'. Finally, the challenges for its adoption, and the elements to be considered for managing the quality of the Digital Twin are presented to give a complete overview of this new technology.

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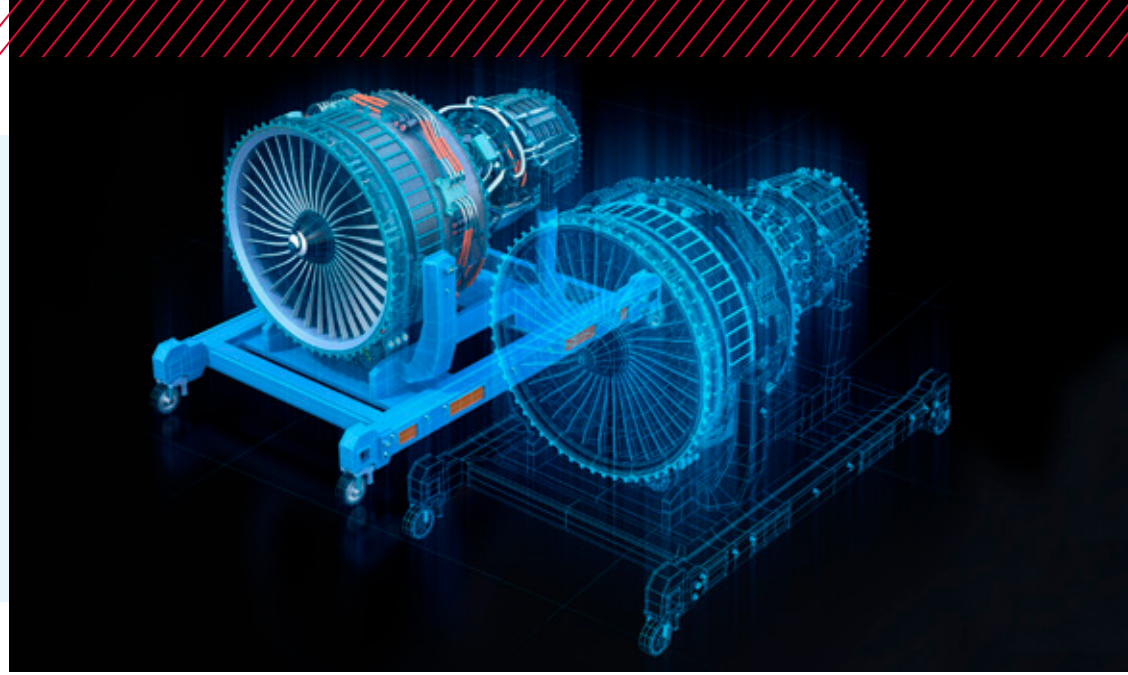
The Idea in brief

The Issue	The Response	The Bottom Line
Digital transformation fostered the evolution towards the digital representation of physical entities.	Physical entities can be represented in digital. Subsequently, optimization and algorithms applied in the digital world improve the physical entity. But also, the other way around.	Digital twins allow organizations to execute digital transformation and link the physcial and digital world.



Demystifying the Digital Twins

Digital Twins is a concept that has been around for quite a few years. Recently, it has gained a lot of attention and it was included in Gardner's and Deloitte's reports of top technological trends since 2018, for three consecutive years (Hartmann & der Auweraer, 2021). But where did the concept of Digital Twins come from and just how disruptive is it really?

The term Digital Twins came into sight in the early 2000s with the digitization of machinery and production systems in the manufacturing industry. At its origin, Grieves and Vickers defined a Digital Twin (DT) as a virtual representation of a product, comprising the physical product, the virtual representation of it, and the data and information flow between the real and virtual spaces (Grieves, 2014). Later, the concept was extended adding what they coined a Digital Twin Prototype (DTP), a Digital Twin Instance (DTI) and a Digital Twin Environment (DTE) (Grieves & Vickers, 2017). The DTP is a prototypical version of the physical product, including all the information required to *describe and produce* the physical version of it. The DTI is the virtual representation of a specific, existing, physical product. The DTE is a multi-domain physics application space for operating on Digital Twins, either for performance prediction or information querying about the state of the physical twin. In addition, in this new conceptual view of the Digital Twin there is a linking between the real and virtual spaces throughout the entire life cycle of the physical product. Hence, the DT enables the design, prototyping, testing, production, and use of its physical counterpart (Minerva, Lee, & Crespi, 2020).

The advent of new technological trends, e.g., Internet of Things (IoT), Big Data, Artificial Intelligence (AI), Machine Learning (ML), fostered the evolution of the original conception of Digital Twins. The digitization era reshaped the concept, from a virtual representation of a physical product, to a digital representation of a physical entity, a process, a service, a system, or other intangible asset (Madni, Madni, & Lucero, 2019; Shao & Helu, 2020; Stark, Kind, & Neumeyer, 2017; Tao & Qi, 2019). This broader vision of the concept, and the vast amount of data that can be acquired from the physical world today, enable the creation of Digital Twins of both, living and non-living things, even humans (El Saddik, 2018; Lu et al., 2020; Saracco, 2019). In this evolution of the concept, Academia and Industry have proposed a myriad of definitions for Digital Twins. Nonetheless, all of them are based on its original principle: a digital representation of a physical asset —understanding by asset anything of value for an organization (Malakuti et al., 2019)— and the linking of the physical and virtual spaces through data and information exchange. The virtual model in the Digital Twin includes the design documents, engineering models, simulations, data analysis and other data that describe the structure, performance, health status and maintenance history of its physical pair. Then, during the operation of the Digital Twin, the virtual model is updated in real-time with the latest data provided by the onboard and surrounding IoT sensors in the physical twin, as well as external data sources from the surrounding environment. All those data readings are used to train AI algorithms in the Digital Twin to provide the information that allows to optimize the performance of the physical twin, perform preventive or corrective adjustments, or support

managers on data/knowledge driven decision making. This continuous data-information exchange is what distinguishes Digital Twins from other similar concepts such as digital model and digital shadow. The digital model is just a digital replica of their physical pair with no data exchange happening between them. In the digital shadow, the data flow occurs in one-way from the physical to the digital object. On the contrary, in the Digital Twin the data-information flow is in both directions, and a change of state in either side can produce a change in their counterpart. This continuous bidirectional flow of data and information, along its entire life cycle, is what makes a Digital Twin a dynamic and evolving entity and not merely a high-fidelity copy. Figure 1 shows the conceptual overview of a Digital Twin.

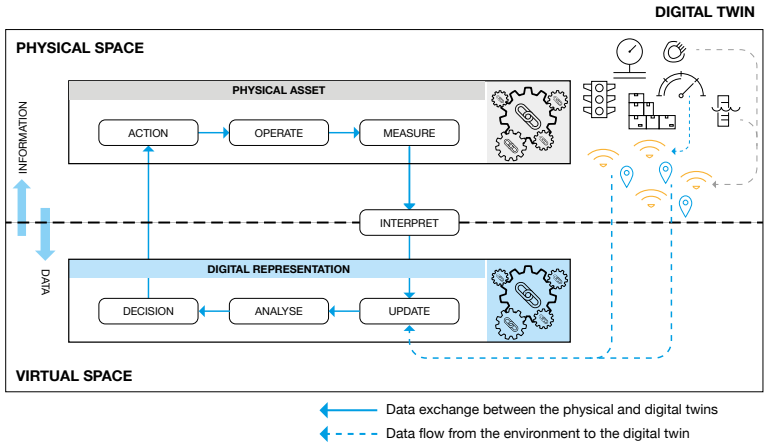


Figure 1. Digital Twin conceptual overview. (Adapted from (VanDerHorn & Mahadevan, 2021))

The different concepts and implementation details proposed during its evolution allows to identify the most important characteristics of Digital Twins. According to (Barricelli, Casiraghi, & Fogli, 2019), a Digital Twin implementation should have the following characteristics. *A seamless connection and continuous data exchange* between the physical and digital world. This is the key to capture and provide the most accurate representation of the physical counterpart. A seamless connection is what allows to keep the twins updated in real-time when a change of status occurs in either pair. A dynamic, eventually sensed, physical twin data. This is the data that describes the status of the physical asset being replicated. It is dynamic because it changes over time, and the frequency of collection depends on the use case. *A dynamic environment data* describing the surrounding environment status. The collected data should describe not only the physical twin, but also its environment. This can include data from other IoT sensors, weather, traffic, noise, and so on. Such data is used to feed prediction algorithms, or it is delivered to domain experts to support decision-making. *Communication processes* that allows the bidirectional data exchange previously mentioned, either between the physical and virtual spaces, between Digital Twins or between the Digital Twin and domain experts. *A data storage system* for descriptive, historical, and real-time generated during the entire life cycle of the Digital Twin. *Ontologies* to equip the Digital Twins with semantics which enable reasoning and inference capabilities. *Data fusion algorithms* to integrate the vast amount of data generated from heterogeneous data sources. *Continuously improving* AI which provide to the Digital Twins the predictive capabilities and insightful data analytics.

Benefits of Digital Twins

Key Points

The use of Digital Twins helps to:

- Integrating data silos
- Anticipate and prevent unwanted situations
- What-if simulations to evaluate different scenarios
- More informed decision-making

Any industry or application area can benefit from the added value associated with the adoption of digital twins . The following are the most important benefits of their use.

Integrating data/information silos (VanDerHorn & Mahadevan, 2021). Continuous bidirectional communication between the physical and real world is a characteristic that must be present in a Digital Twin implementation. In addition, this data-information exchange takes place during the whole life cycle of the implemented system. This implies that all the components that belong to the environment and are replicated by the Digital Twin should share their data within a common platform. Usually, within organizations, all the information systems, operational data, or any other datasets generated by daily processes are kept isolated, each of them serving particular use cases (e.g., finance, marketing, planning) and specific types of users (e.g., managers, operators). On the contrary, in a Digital Twin all this data is collected and shared, either to other Digital Twins, other systems, subsystems, domain experts or decision- makers that make use of it at different levels of granularity. This way, all the actions taken automatically by the Digital Twin itself, or by human users, are based on a complete picture of the environment being replicated.

Digital Twins allow to **foresee unwanted situations**. Usually, in an industrial manufacturing setting, corrective maintenance is performed after a failure occurred, causing a business downtime because of unscheduled maintenance operations. Other companies improved their practices and try to estimate the lifetime of the physical assets to apply preventive maintenance before the actual failure occur. Although with this approach the maintenance operations are programmed in advance, there is still a downtime in business operations. Hence, in the ideal scenario, the interruptions of business operations should be reduced as much as possible. Digital Twins facilitate the achievement of this goal with their predictive capabilities. AI and ML algorithms use the data gathered from the physical environment combined with the operational historical data to predict the behavior of the emulated asset. Hence, **a predictive maintenance model** in the Digital Twin anticipates a machinery failure right before it happens. This provides a balance between corrective and preventive maintenance approaches, avoiding long operation interruptions and thereby saving time and costs.

Digital Twins allow to **evaluate the effects of decisions before applying them in practice**. Simulation capabilities of Digital Twins enable testing what-if scenarios to evaluate the effects of decisions. Digital Twins simulations allow to identify unexpected scenarios, analyze the system response to them, and test actions to mitigate the unwanted behavior. All of this without affecting the real assets (Rasheed, San, & Kvamsdal, 2020). For example, the Digital Twin of a service could be used to simulate the demand and evaluate different resource utilization scenarios to identify the most optimal one. In the healthcare industry, a Digital Twin of a patient could be used to test drugs and assess their effects before to apply them in the real patient. In a smart city Digital Twin, traffic flow simulations allow to evaluate strategies to reduce traffic congestion.

Efficiency and safety are improved with the use of Digital Twins. For example, in automating repetitive tasks which are better performed by machines. In addition, risky situations can be avoided by humans by using a Digital Twin to operate dangerous environments remotely. Hence, humans focus on creative and innovative work, just monitoring and controlling the actions performed by the Digital Twin in threatening environments (Rasheed et al., 2020).

More informed decision-making is another benefit of Digital Twins utilization (Rasheed et al., 2020). IoT sensors monitoring the physical assets in real-time, historical data about the performance and operation of the replicated entity, and the power of AI and ML algorithms to perform advanced analytics, provides decision-makers with a complete view of the dynamics of the twinned environment. The Digital Twin provides the insights for data-driven decision- making. Hence, the decisions are based on precise and accurate data which reflects the whole picture of the evaluated situation.

As a result, the capabilities of Digital Twins enable **process optimization, higher efficiency, and savings**.

Digital Twins applications

Key Points

- This section describes real examples of how Digital Twins are being used in Manufacturing, Smart Cities, Health Care, Supply Chain, Construction and Education.
- These examples include Digital Twin implementations in the Netherlands and Projects being executed in the Northern Region.

While Digital Twins initially appeared in manufacturing, their value can now be seen in other areas way beyond it. The following are a few examples of how Digital Twins are being used today.

Manufacturing

Digital Twins originated and grew in the manufacturing industry. Today Digital Twins are one of the enabling technologies for smart manufacturing and Industry 4.0 (Tao, Zhang, Liu, & Nee, 2018).

In the area of Product Life Cycle Management, Digital Twins are presented as an effective approach to overcome data isolation and data duplication among the different stages of a product's life cycle, i.e., design, manufacturing and service (Tao, Cheng, et al., 2018). According Tao et al. (2018), during the design phase Digital Twins allow testing and validating the models before manufacturing the real product. In addition, inefficiencies in manufacturing arise from the lack of an optimization mechanism for resource management, the difference between the production plan and its actual execution, and inaccurate manufacturing process control. A Digital Twin Shop Floor is proposed as a solution to integrate the physical space and data generated during the product manufacturing stage. Moreover, the product service is related to the product use and maintenance phases. At this stage Digital Twins can be used to detect, understand and foresee anomalous events

by means of data collected from the physical product. At SIEMENS, they realized the importance of Digital Twins in the manufacturing industry as an enabler of seamless integration of the data generated at each stage of a product's life cycle (Rosen, Von Wichert, Lo, & Bettenhausen, 2015).

Another example of Digital Twins in practice is at General Electrics, where they use it for predictive maintenance in the Power Generation, Oil and Gas industries. They have created Digital Twins of jet engines, wind-farms, off-shore oil rigs, power generation equipment, pumps, compressors, chillers, among other things, for what they have over 300 of DT blueprints. The company reports 1.5 billion US dollars on savings to their customers with the use of Digital Twins (Parris, n.d.). The automotive industry is also leveraging the potential of Digital Twins. TESLA creates a Digital Twin for each car they manufacture. Then, the factory receives real-time data about the status of the car and uses it later for automatic adjustments or reconfiguration (Barricelli et al., 2019; Schleich, Anwer, Mathieu, & Wartzack, 2017).

Smart Cities

The rapid development of sensing and communications technologies has enabled the conception and realization of a Smart City. A city where real-time data coming from IoT sensors and other data sources allows to record and monitor the state of buildings, parks, roads, bridges or any built infrastructure. This data in combination with operational data from urban- related processes allows to assess and optimize the performance of the services offered to the citizens. In this context Digital Twins of Smart Cities are used to monitor and control physical urban activities (Austin, Delgoshaei, Coelho, & Heidarinejad, 2020; Dembski, Wössner, Letzgus, Ruddat, & Yamu, 2020). The Digital Twins support decision makers in the planning and operation of complex urban-related processes, e.g., urban mobility, energy efficiency, water management, urban planning, control and risk management.

An interesting example is the implementation of a Digital Twin for the city of Herrenberg, Germany (Dembski et al., 2020). In this use case, the Digital Twin of Herrenberg comprises a 3D model of the built environment, a mathematical street network model, urban mobility and wind flow simulations, people's movements patterns, IoT sensor's data, and quantitative and qualitative data, about people's perception gathered in a collaborative system. The implementation of the Digital Twin allowed testing and evaluating the impacts of different scenarios and potential solutions for the challenges of the city (e.g., high traffic load and air pollution). In addition, having a virtual space where citizens can interact and be part in the solution of their problems, makes them more willing to get involved in public participation processes.

The city of Porto in Portugal, implemented H2Porto, a "Technology Platform for the Integrated Water Management of the Urban Water Cycle" (Bentley Systems, 2019). H2Porto is a Digital Twin that integrates over dozens of software systems, including data from water supply, wastewater drainage and treatment, stormwater drainage, surface waters, and coastal bathing water quality. The Digital Twin is used in predictive operational analytics to forecast flooding and water quality issues, for early failure identification and prescriptive actions to ensure resilience of water infrastructure, and to improve city services and responsiveness. The outcomes of the H2Porto Digital Twin are operation gains of 25%, reduction of failures in water supply of about 30%, reduction of duration of pipe bursts repairs of about 8%, improved decision-making due to real-time data access, and data stability and reliability close to 99%.

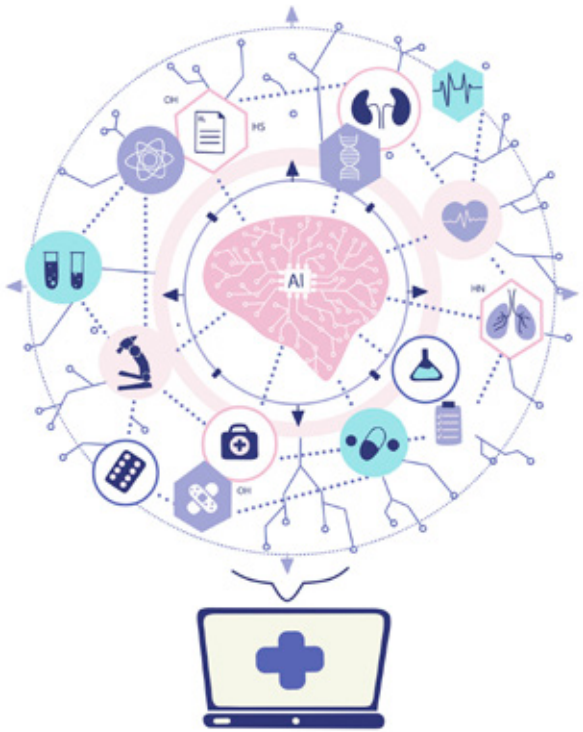
Virtual Singapore is another example of a Digital Twin that relies on 3D semantic modelling to create an exact virtual copy of the city-state Singapore (National Research Foundation of Singapore, 2019). Virtual Singapore integrates data about terrain and water, infrastructure, transportation, and even vegetation information. In addition, data about demographics, traffic, temperature, humidity, noise and light intensity is also collected in real-time by IoT sensors worn by students. Thereby, the Digital Twin of Singapore is used to support test-bedding concepts and services, planning and decision-making. For instance, Virtual Singapore is used to test the coverage areas of 3G/4G Networks. It allows to analyze transport and pedestrian movement patterns and simulate crowd dispersion in order to test evacuation protocols during an emergency event. Moreover, to prevent heat waves affect the comfort of its citizens, urban planners use the Digital Twin to assess how the placement of new buildings will affect wind flow across the city, and to evaluate measures to mitigate that. Furthermore, Virtual Singapore is leveraged by the research community through partnerships between government agencies, universities and the private sector to use the Digital Twin as an experimentation environment for innovation, research and development projects.

Amsterdam is another use case for Digital Twins that aims to become the city more livable and 'smart'. The Digital Twin is focused on monitoring traffic flows in the surroundings of the ArenA stadium. The application guides the visitors to right parking place when it is very busy. KPN will play an important role in this implementation by means of its 5G Network (KPN, n.d.).

Healthcare

The first applications of Digital Twins in healthcare were predictive maintenance and performance optimization of medical devices (Barricelli et al., 2019). Today, big companies like General Electrics and Siemens extended its use to complete coverage in the healthcare industry.

GE Healthcare, together with GE's Global Research Center, created what they called 'Hospital of the Future Simulation Suite', a Digital Twin to mimic hospital operations (GE Healthcare, n.d.). The Digital Twin allows to model behavior of patient and staff, variation in demand and supply, and patient pathways with the aim of optimizing patient flow, capital investment, and operational efficiency. Care givers and hospital administrators can test what-if scenarios that help them to determine which actions to take in a scenario-based, data-driven approach. The GE's Digital Twin implementation has helped to optimize bed use, surgical block schedule, and staffing planning to meet the dynamics of the predicted demand.



Siemens Healthineers in a partnership with the Mater Private Hospital from Dublin, created a Digital Twin of the hospital's radiology department (Siemens Healthineers, 2019). The idea of a Digital Twin to optimize the operations at radiology department came from the inability to meet the increased demand for medical scans. Growing the department's size was unfeasible due to the lack of space and the overall costs that would be incurred. In this use case, the Digital Twin leverages simulations, and it is enhanced with data coming from real-time location systems to provide a detailed view of how the hospital is working. Once again, what-if scenarios allowed to evaluate the impact of increasing patient demand within the radiology department, and how it affects on resource utilization, staff, and other areas of the hospital. The outcomes were shorter waiting time for patients, faster patient turn around, increased equipment utilization, and lower staffing costs by reducing the overtime work per day.

In addition, Siemens is revolutionizing healthcare industry with the creation of digital models of human organs, being the ultimate goal the Digital Twin of the entire human body (Siemens Healthineers, 2018). They started with a Digital Twin of the heart, enriched with deep learning algorithms to simulate the multi-scale physiological processes of this organ. Cardiologists at the University of Heidelberg are testing those algorithms, evaluating responses to cardiac re-synchronization therapy on the Digital Twin before the actual intervention in the real patient.

Moreover, the digital revolution have enabled healthcare practitioners to use Digital Twins for tailored treatments evaluation, facilitating the expansion of precision medicine. The use of Digital Twins for personalized medicine, i.e., precision medicine, goes from Digital Twins for testing and identifying the best performing drugs on specific diseases (Björnsson et al., 2020), to Digital Twins of patients for tailored nutrition guide (Gkouskou et al., 2020), and to a Digital Twin reference model for the design, development, and operation of personalized treatment management systems (Rivera et al., 2019). The ability to execute trial-error tests on computer models instead of people, and to virtualize hospitals' processes and workflows, have made Digital Twins to become a disruptive technology in the healthcare industry.

Supply Chain

One of the challenges faced by Supply Chains is the management of disruptions and its recovery mechanisms. Prior identification of disruption scenarios and nodes in the supply chain prone to fail is essential for determining proper actions and recovery mechanisms in the presence of disruptions. Model-based and data-driven approaches implemented in a Supply Chain Digital Twin (SCDT) are proposed for disruption risk

management (Ivanov & Dolgui, 2020). The SCDT allows to monitor the supply chain network state. Real-time data from IoT sensors, track and trace systems, RFID systems, third-party data about natural, financial, or political risks, and historical disruption data feed disturbance prediction AI algorithms to support decision-makers to anticipate interruptions. If detected, simulations of disruptions' dynamics and the evaluation of alternative supply network topologies, enable recovery policies optimization.

Information asymmetry, in remanufacturing supply chain, refers to the fact that some actors in the chain have more or better information and the lack of data sharing upstream and downstream enterprises in the chain. The inability to obtain updated, real-time data at every stage in the supply chain hinders decision-making and process optimization. According to the study carried out in (Chen & Huang, 2020), the current solutions to this problem are not systematic and too theoretical. Thus, Digital Twins are proposed as a solution for solving information asymmetry in the supply chain of the remanufacturing industry. By concept, Digital Twins implementations involve a continuous bidirectional flow of real-time data between the physical and digital world. Therefore, having a Digital Twin of the remanufacturing supply chain imply all the data and information, generated at any enterprise in the chain, will be shared and available in real-time. It is important to point out that its applicability depends on enterprise demand and application willingness, information security, and data integration technology (Chen & Huang, 2020). However, the solution for the latter is straightforward due to the technological advancements today, e.g., IoT, Big Data, Cloud Computing.

Construction

In the era of digital transformation, construction industry is considered among the least digitized (Greif, Stein, & Flath, 2020; Leviäkangas, Paik, & Moon, 2017). To cope with the current demand within the industry 4.0, i.e., real-time data-driven decision-making, Digital Twins are a viable option to revolutionize construction industry as well.

A Digital Twin-based decision support system for non-high-tech industries (e.g., construction) is proposed in (Greif et al., 2020), to monitor and control the bulk silo dispatch and replacement processes. Currently, when a construction company requests a bulk silo, it is filled and weighted at the production plant. Then, the silo is transported to the construction site and returned to the plant after its use. The bill is calculated based on the current weight compared to the weight at delivery. On the other hand, if the company requires more material, it requests a replenishment. Then, a truck from the production plant is sent with a weighted amount of material to the construction site to refill the original silo. The bill is calculated in the same way, after the silo is returned to the production plant. There are clear limitations in the current dispatch and replenishment processes. First, the silos need to be returned to the plant for billing. They can not be used by other customers directly, even if the silo has enough material to meet those requirements. Second, the construction company is not aware of the fill level of the silo. Hence, a replenishment is requested after they realize the silo is empty. This leads to work interruption until the new material arrives to construction site. After a silo is delivered, the production plant is not aware of the usage of material at the construction site. Thus, remaining material could be stored at construction site for a long period, until the contractor decides to return the silo, possibly resulting in that material losing its good condition for further use.

The aforementioned real-world scenario from the industry raises the bar for improvements. A Digital Twin of these processes should include data about orders, customers, silos, and trucks. Of course, the implementation of such a system would require large investments, but the benefits of its implementation could be seen at short, medium, and long term (Greif et al., 2020). Simulations performed on the Digital Twin using three years of historical data showed that the costs of transportation could be reduced by 25%. Reducing transport by means of intelligent data-driven decision-making not only represents monetary benefits but also environmental gains because of the reduction in CO2 emissions (Greif et al., 2020).

Structural Health Monitoring (SHM) is another use case for Digital Twins in construction industry. An example is a framework for creating Digital Twins of bridges, implemented using two monitored railway bridges in Staffordshire, UK (Ye et al., 2019). According to the study, there are several limitations of current practices in SHM of bridges. For instance, the difficulties for storing, processing and interpreting the available data because of the size and heterogeneity of the bridges' datasets. The heterogeneity of bridges' data management systems hinders querying relevant data. As a consequence, there is a limited interoperability across such systems because of different data formats. Thus, based on the conceptual principle of Digital Twins, they are seen as the technological tool that could enable integration, sharing, analysis and interpretation of bridges' health status data at every stage of their life-cycle.

In the Netherlands, the "Rijkswaterstaat" (Directorate-General for Public Works and Water Management) are the forerunners in the field of Digital Twins. They created a Digital Twin of the tunnel under construction that connects the A16 and A13 in Rotterdam Noord. The Digital Twin is being used to simulate an identical replica of the tunnel and anticipate possible incidents. It also allows to enhance the coordination between the stakeholders of the project (KPN, n.d.).

Education

The Digital Twins' capability of being a high-fidelity representation of its physical counterpart allows them to be used as an educational tool as well. In this context, Digital Twins are presented as a pedagogic tool to assist the learning process in certain courses at university level (David, Lobov, & Lanz, 2018a, 2018b). Leveraging the simulation capabilities of Digital Twins and their ability to provide real-time information, they are used to apply the knowledge acquired on theoretical lectures in the classroom, by carrying out practical laboratory exercises. All the exercises are performed on a virtual representation of the physical process. This allows the students to understand every detail by playing and manipulating the virtual asset, as it would be the physical one, without affecting the real operation. The practical sessions using the Digital Twin are supervised by the professor, and only after successful performance of the students, they are taken to the physical site to apply the learned skills.

In addition, the notion of "cognitive Digital Twins" allows them to be an assistive tool to enhance the way that we, humans, learn. The wealth of data available today, makes it difficult to keep the pace with the explosion and obsolescence of knowledge (Saracco, 2019). While the overwhelming amount of information makes it difficult to know what we do not know, the demand for skilled professionals pushes us to continue learning. Hence, having a Digital Twin of our learning process, featured with cognition capabilities, would be the right tool to help us to organize and command the way we acquire knowledge. As stated in (Saracco, 2019), it would depend on us to feed the Digital Twin with the most accurate information about our learning path, e.g., our curricular education, conferences attended, papers read, papers submitted and published, training courses, etc. This way, our cognitive Digital Twin could infer the knowledge we have, what is missing and how to fill those gaps. Moreover, with all that information at hand, the Digital Twin could be used for implementing customized education programs.

Digital Twins in the Northern Netherlands

Six Dutch Universities (RUG, TU/e, TU Delft, Twente, Leiden and Tilburg), under the leadership of the University of Groningen, in a joint project with twelve industrial partners develop Digital Twins if High-Tech Systems. The Digital Twin are used to simulate and monitor those systems function and anticipate unwanted behavior using AI-based predictions. The Digital Twins can be used by different industries with the aim to accelerate time-to-market or enhance production systems (Innovatiecluster high tech systems Drachten, n.d.).

The challenges for its adoption

Key Points

- This section describes the challenges that should be taken into account before starting a Digital Twin implementation.
- In addition, it depicts the efforts of local and European organizations to support Small to Medium Enterprises to embrace Digital Twin technologies.

Although the benefits of Digital Twins are clear, their implementation requires a deep understanding of the burden associated with its adoption. Recent developments on Digital Twins are the result of the advancements of other technologies such as AI and IoT. Therefore, the challenges for a successful implementation and widespread adoption of Digital Twins go hand in hand with those of its enabler technologies.

The potential of Digital Twins goes beyond storing all available data about the past and present of its physical pair, but the capacity to leverage such data to anticipate the future, i.e., to get insights for supporting data-driven decision-making. Data Analytics plays an important role to achieve this goal. Insightful data analytics relies on complex and computationally demanding AI deep learning algorithms. Hence, the data collected from the real-world by the Digital Twin is fed to AI and ML algorithms to find patterns and extract knowledge from it.

Unfortunately, all that processing power comes at a price, a sometimes highly-expensive IT infrastructure. State-of-the-art AI deep learning algorithms run on GPUs, which can costs from 1,000 to 10,000 USD (Fuller, Fan, Day, & Barlow, 2020). Besides computational power, it is important to think of strategies to leverage the infrastructure already in place combined with the new IoT technology available in the market. Although today there are several options for cheap IoT sensors, changing all the IT infrastructure may imply high additional costs. Then, the challenge is how to integrate old IT infrastructure and legacy systems with current IoT devices and applications. This shows that the initial investments for running a Digital Twin, and exploit it at its fullest capacity, could be a decisive factor for a go-no-go decision in a small or even medium-sized enterprise.

Today, companies can decrease its IT infrastructure costs by contracting cloud service providers. Current cloud solutions offer storage, computation capacity, relational and NoSQL database services, developer tools, machine learning pipelines, virtual servers, or even entire data centers according to the needs of their clients. However, a common

concern when opting for such solutions is the mistrust of giving the control of their data to third party companies and that privacy and security over its information assets could be compromised.

Then, another challenge of Digital Twins' implementation is to guarantee **privacy and security** of the data collected. Regarding data analytics and AI, the challenge falls on Law and Regulations' compliance. The power of AI has disrupted almost every industry today, but together with the success comes uncertainties. To what degree the results obtained through AI is ethical and fully compliant with all local, regional, national and international regulations. For instance, the General Data Protection Regulation (GDPR), the Europe's new data privacy and security law, is "the toughest privacy and security law in the world" (GDPR.eu, n.d.). Therefore, designing and implementing a Digital Twin compliant with such regulations may impose significant challenges. Federated learning is proposed as a possible solution to overcome privacy and security issues (Fuller et al., 2020). This is a concept proposed by Google, where machine learning models are trained in a distributed fashion. Data owners share the model, but its data is kept locally during training. At the end, the optimized ML model is shared back to the users. Hence, data analytics in the Digital Twin could be implemented using federated learning to avoid data sharing beyond the place where it is being created.

Trust is another concern that comes hand in hand with privacy and security. AI is a relatively new technology and there is still a lot of debate around the possible negative effects of its use. For example, the case in the UK where a machine learning algorithm used to profile visa applicants was criticized for being "racist", created skepticism about AI credibility. After a legal challenge against such system, the UK's Home Office stopped using the algorithm in August 2020 (BBC news, n.d.). The "Mirai" botnet, considered the largest DDoS attack recorded until now, infected about 15 million of IoT devices by attempting to login, by brute force, the devices configured with default usernames and passwords (Vishwakarma & Jain, 2020). The intent of these examples is to show that trust on Digital Twins depends on how the organization and end-users are aware of the challenges of its implementation and use. From the organization's point of view, it has to ensure that their algorithms comply with privacy and security regulations. The European GDPR requires that automated decision-making should provide meaningful explanation of the logic involved in the process. Thus, model validation and Explainable AI could raise trust on the insights provided by the Digital Twin. Understanding where the outputs of ML algorithms come from guarantees compliant systems and can make decision-makers appealing to exploit the Digital Twins potential.

Connectivity and **useful data** are other major challenges to be addressed when designing and implementing Digital Twins (Fuller et al., 2020; Rasheed et al., 2020). The key for a successful implementation of a Digital Twin is the readiness and efficiency of the bidirectional communication mechanism between the physical and virtual spaces. The monitoring and actuating capabilities of the Digital Twin rely on real-time data obtained from the physical world. The accuracy of the predictions, simulations and the overall performance of the Digital Twin depends on the timeliness and quality of the data used for analysis. The large number of IoT devices that could be deployed on a Digital Twin environment generates Big Data. It is "Big" not only because of the amount of data generated, but its large variety and high generation rate. Sensors' data is faulty which requires pre-processing to ensure its quality. Latency in communication can hinder the timeliness needed for Digital Twins data provisioning. This, added to unavoidable power outages, and unintentional software and deployments errors, poses a challenge for Digital Twins' implementation. The type of data collected, the data collection rate, and the number and placing of sensors depend on the application domain. Too few data points can produce inaccurate predictions while too many can originate redundant and unnecessary details causing transmission bottlenecks. Therefore, implementation of Digital Twins requires a thoroughly planned connectivity and data collection strategies, guaranteeing that the virtual model evolves together with the physical one and vice versa.

Currently, Digital Twins are being used for solving real-world problems in different industries. However, each project, vendor or implementer of Digital Twins propose their own models and architectures. There is **a lack of standards** for designing, modeling and implementing Digital Twins (Fuller et al., 2020; VanDerHorn & Mahadevan, 2021). The ISO/DIS 23247-1 is an advancement on standardization of Digital Twins. However, this standard is focused specifically on Digital Twins for manufacturing. Another effort towards Digital Twin standardization is the Digital Twin Consortium, which brings together academia, government and industry to provide a common vocabulary, architectures, and security and interoperability directives for Digital Twins implementation (Object Management Group, n.d.). Their members include companies, leading in their respective industries e.g., GE Digital, Bentley Systems, Microsoft, Dell, working on technical guidelines and taxonomies, reference frameworks, and requirements for new standards on Digital Twins.

The aforementioned challenges might seem unmanageable for Small to Medium Enterprises (SME). However, there are regional and European initiatives to enable SME to embrace Digital Twins technologies. TNO combines data, models, and business processes to create a digital replica of a physical life cycle of an asset. TNO provides

guidance to SME offering them an assessment tool to identify their digitization needs. Then, TNO support goes from creating the digital models SME requires, assisting SME in the data collection process, or any other tasks related with the implementation of Digital Twins (TNO innovation for life, n.d.). DIGITbrain is a European initiative to give SME access to Digital Twin technology. The aim is to offer AI-based Manufacturing-as-a-Service to SME to simulate any stage of a manufacturing process. This will allow SME to make predictions and to run what-if scenarios to make data- driven decisions (EGI.eu, n.d.).

The challenges for Digital Twins adoption presented in this section provide a general overview of the details that need to be taken into account before embracing on a Digital Twin implementation project. Users and implementers need to be conscious that Digital Twins should not be used to merely follow a trend, but a deep understanding of the pros and cons of this technology is required to ensure a successful Digital Twin application.

Managing the quality of Digital Twins

Key Points

This section describes the main factors to ensure the quality of the Digital Twin:

- Sensors composition and coverage
- Model creation and configuration
- Machine Learning pipelines
- Hyperparameter tuning
- Model quality optimization

Assessing the quality of the Digital Twin is one of the essential questions faced by any system designer and developer. There are many parameters that can compose the quality of the Digital Twin. One can think of expressiveness – how simplified is the digital version of the physical environment? Does it capture well all the intricacies, complexities, chaoticism of the physical world with minute precision, or does it provide only a rough model for a couple of variables? Another potential quality parameter is the computational efficiency – how many computational resources do we need to keep the real-time simulation link up and running?

But arguably the most important quality parameter of a Digital Twin for simulations and scenario predictions is the degree of trust we can put into the system and its risk of failing to model the real physical conditions correctly. In other words, the Digital Twin's accuracy.

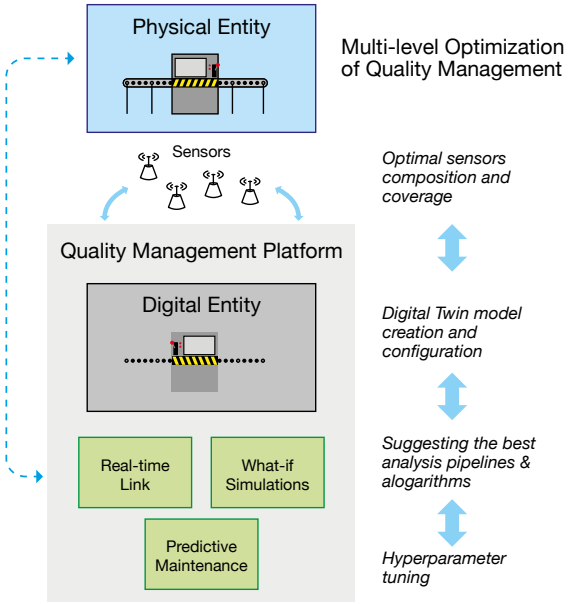


Figure 2. Quality Management platform and multi-level optimization

Optimal sensors composition and coverage

This is arguably the most important level of Digital Twin construction. The physical world is perceived through the collection of sensors, and the final quality and accuracy of the twin is hard-constrained by the quality of coverage that these sensors provide. Sensors can be of diverse nature: we are talking not just about the standard IoT sensors, such as passive-infrared for movement detection, sound sensors, videocameras, pressure, air quality sensors and similar, but also about other ways to collect information, such as digital room schedules, device specifications. In the absence of a proper device to measure certain features, the system may even be constructed in such a way that allows to ask humans, operating the system, to provide missing information. While this may be undesirable, due to the strive for full automation, for some cases this may be the most practical way to gather the required knowledge.

The original physical entity is called fully observable, when existing sensor coverage can detect all potential changes in the state of the entity and its surroundings. While, at the first glance, it may look like it is necessary to have a fully observable system to create a perfect Digital Twin, in fact, in many cases full observability is not required. For example,

think of a system that wants to keep the temperature in a room within a comfortable range, but only when there are people inside the room. The Digital Twin of such a system does not need to know the exact number of people in it for the perfectly optimal thermostat control. It only has be able to distinguish between zero (no one is present) and non-zero (at least one person is present) states. On the other hand, if we are to make the system a bit more complex, and require it to control the air quality as well, the number of people in the room becomes a meaningful variable that will impact potential control actions of the system. Therefore, in this case additional sensors to measure the number of people will be required.

In the work by Degeler and Curry (2014), a system with partial observability of the physical environment is considered. It is shown that in many situations it can be computed in real-time whether the available incomplete information is enough to decide on the actions that have to be performed, and often optimal decisions can still be made even with gaps in understanding of the environment. On the other hand, there are situations when missing information becomes critical to the correct decision making. The system can then create a decision tree that is used to guide humans to provide missing data or to perform certain actions.

Model creation and configuration

Once the sensor coverage is established, the next level of managing quality of the Digital Twin is *creating and configuring* a well-suited model of the physical entity. In general, any model should provide a certain representation of the states in which the physical object can be present and transitions between those states. The most common representation of the state is with a *feature vector* and transitions is with a change vector, that can be added to the initial state feature vector to result in the new feature vector, that describes the state after the transition (the event).

Representation with *ontologies* is also very common for Digital Twin environments. Unlike standard structured data representation in a table-like manner (with a collection of data points each having a set of the same features), knowledge representation with an ontology captures a collection of entities and relations between those entities, and represents them in a graph-like manner. The dataset in such a representation is often called a *knowledge graph*. A standard ontological statement consists of three parts: subject–relation–object. For example, Figure 3 shows, how basic ontological relations can look like for an office activity recognition scenario (Nguyen et al., 2013). Web Ontology Language (OWL) provides a common standard notation for ontological representation (McGuinness, Van Harmelen, 2004).

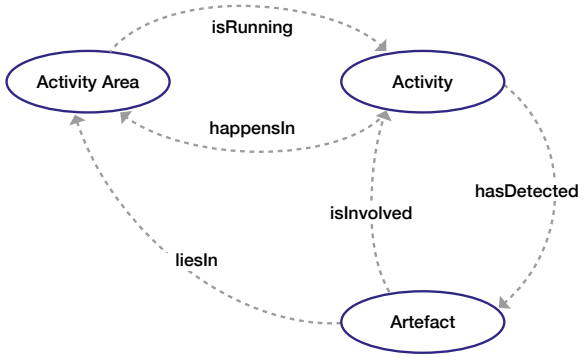


Figure 3. Office activity basic ontology

Machine learning pipelines

Whatever model representation is chosen, this data should be usable by the Digital Twin system to simulate the current physical world and, often, to predict possible future states and model what-if scenarios. For that, most commonly, a variety of different machine learning algorithms is employed, such as logistic regression, support vector machines, (deep) neural networks, clustering and pattern detection, etc. For Digital Twins that control the physical entity, machine learning steps are often followed by additional reasoning steps to decide on the best course of actions, commonly modeled as a constraint satisfaction problem, or an automated AI planning problem.

The whole reasoning process can be split into a number of reasoning steps, which together are normally called a *pipeline*. Think of the most common pipeline scenario: (1) Raw data is collected from sensors. Each sensor has its own data processing step, which may include preliminary data cleaning, error detection, data transfer to the central hub, data transformations, etc. (2) Data from different sources is collected together and further processed to form a coherent view of the physical world. This may include consistency analysis, feature extraction, further cleaning and logical inference. The data is transformed into the chosen model representation. (3) Chosen machine learning algorithms are applied to the data. This pipeline step can normally be further split into separate training and detection or prediction steps. It is also common to employ several different machine learning algorithms, in which case each of them can be represented as their own pipeline step. (4) Once the trained machine learning algorithm is applied, the system can make decisions on the possible execution of actions. This pipeline step can involve something as simple as showing the results of the prediction in a dashboard, but can also contain further complex reasoning steps, that finish with passing the execution of the decided steps to the IoT actuators.

Hyperparameter tuning

The final level of improving the quality of the Digital Twin is the traditional machine learning *hyperparameter* tuning approach. This allows us to assess, under the current conditions, what the performance metrics (accuracy, f1-score, mean square error, and so on) of the chosen predictive approach are, as well as find the best configuration of parameters for the chosen predictive approach. Among the most commonly chosen hyperparameter tuning methods are grid search, randomized parameter estimator, and Bayesian optimization approach applied to the parameters feature vector.

However, traditional machine learning hyperparameter tuning operates within a very constrained world of possibilities. In particular, it assumes the permanency in the data collection, and dataset quality and features.

Model quality optimization: bringing all levels together

When dealing with the construction of a Digital Twin, a typical system has many degrees of freedom, normally coming from the ability to change the configuration of sensors, add new physical sensors, change the representation, change the simulation parameters of the Digital Twin, and so on. Think of a case, where, after extensive data collection and predictive algorithm construction, a hyperparameter tuning is performed that allows to improve accuracy by 2%. Meanwhile, a new vibration sensor should have been added to a part of the mechanism that is not being adequately monitored, and adding data readings from that sensor to the predictive feature set would have resulted in a considerably larger increase in the accuracy of failure detection. Moreover, the variable data availability may affect the choice of the Digital Twin model, and by updating the model, we may need to re-evaluate the best suited data science algorithm used for a given purpose.

Therefore, it is important to design a system that optimizes the quality of the Digital Twin model on several levels, as shown in Figure 2. Starting at the physical level, the system optimizes the placement of sensors to minimize their initial installation and maintenance costs, while maximizing the observability of the physical units and surrounding environment. At the next level, the Digital Twin model itself is constructed based on the incoming data sources, and the real-time link is created to its physical counterpart. At the third level, the constructed Digital Twin model and the collected dataset are used to find the best combination of data science algorithms for a given question (e.g. for the prediction of the future state of the unit or its part), while at the last level, the hyperparameter tuning of the chosen algorithm is performed.

Important to note, that it is not a strictly unidirectional top-to-bottom optimization system, and decisions done at every level are back propagated, because they can affect the optimality of the solution on previous levels. As such, it is a close-loop system that continuously re- evaluates decisions done at every level and provides suggestions for real-time re-configuration when necessary.

Digital Twins: the future is now

Digital Twins have allowed to materialize what was envisioned and seen as science fiction just a few years ago. Their original conception as a model of a physical device evolved to a “living” digital representation of anything of value for an organization, being either a device, a process, a service or the entire organization itself. Today, digital twins are considered the key for digital transformation and organizations that want to embrace the wave of industry 4.0 are betting on them. Digital twins have disrupted the way organizations operate and function today. Their benefits have popularized their use in almost every industry, from manufacturing, to aerospace, to healthcare, education and so forth. Assisting end-users from design to monitoring, analysis and prediction, they provide insights and support decision-making based on real-time data from the real world.

Technologies like IoT and AI are shaping the way digital twins are implemented. Thus, the benefits and challenges of a digital twin implementation go hand in hand with the benefits and challenges of those other technological trends. Organizations and end-users should be aware and acquire deep understanding of the pros and cons of these technologies in order to be able to engage as soon as they can with a digital twin implementation project. With the ubiquitous nature of these technologies nowadays, the future is now.

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#9

Pricing in the Digital Age

A Roadmap to Becoming a Dynamic Pricing Retailer

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Groningen Digital Business Centre (GDBC) - Pubished April 2021

Dynamic pricing and personalized pricing emerged as novel pricing approaches in the digital age. Shifting to these novel pricing approaches can increase company profits by 3% to 25%. Dynamic pricing allows firms to smoothen demand and supply and to remain competitive facing price pressure. Personalized pricing enables companies to tap into consumers' differing willingness to pay.

However, such profit-increases only set in if managers make good choices when implementing their company's pricing approach. Managers need to overcome potential adverse consumer reactions and need to comply with privacy regulations. Managers need to create an appropriate IT infrastructure, synchronize prices in their on- and offline channels, harmonize prices in their product portfolio, and nurture a mindset that is open to automating prices.

This book chapter discusses these aspects and provides practical guidance for decision-makers. This discussion enables managers to decide whether and how to implement a dynamic pricing approach.

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The Idea in brief

The Issue	The Response	The Bottom Line
• Online markets offer unique insights on customers and competitors for effective pricing decisions. • Two novel pricing approaches emerged whose effective implementation poses managerial challenges: - Dynamic pricing - Personalized pricing	Pricing in the digital requires that managers: • Address adverse consumer reactions • Comply with regulations • Overcome IT challenges • Develop a multichannel pricing strategy • Nurture a culture that is open for pricing automation	Dynamic pricing can increase company performance if managers: • make appropriate design choices • effectively overcome implementation challenges

Dynamic Prices: Overcoming the Paradigm of Fixed Prices

Changes in the way companies set their prices have been in the center of interest for the last decade. Readers of the *Wall Street Journal* most likely have witnessed headlines such as:

- "Coming soon toilet paper priced like airline tickets" (Angwin and Mattioli 2012).
- "The high speed trading behind your Amazon purchase" (Mims 2017).
- "Now prices can change from minute to minute" (Nicas 2015).

Those headlines address an essential manner in which companies nowadays set their prices: companies more and more break with the last century's norm of fixed prices and move to dynamic prices. Increased data availability and new technologies caused the rise of dynamic pricing. New technologies help companies to identify consumer behavior patterns more quickly and efficiently and to align prices accordingly. Simultaneously, increased online price transparency pressures companies to monitor and respond in real-time to competitive prices (Fisher, Gallino, and Li 2018).

Companies break the norm of fixed prices in two ways. First, online prices fluctuate over time but are the same for all consumers; a practice referred to as time-based dynamic pricing (in the following, I will only call this practice "dynamic pricing"). For example, reporters noted that on Amazon.com, the price for a microwave oven changed nine times during a single day, with prices varying between $744.46 and $871.49 (Angwin and Mattioli 2012).

Second, companies offer at the same point in time different prices to different consumers, referred to as consumer-based dynamic pricing (in the following, I will refer to this practice as "personalized pricing" to differentiate it from dynamic pricing clearly). Media reports observed that the price for a monitor in an online shop depended on how the reporter accessed the online shop, either directly or via a price comparison portal. The monitor price was 187€ lower if the reporter accessed the online shop via a price comparison portal.

Investigations demonstrate that retailers can increase their profits with those novel pricing approaches. Depending on the industry, studies indicate a revenue increasing-potential of dynamic pricing between 2% and 8% and potential profit increases between 3% and 25% (BenMark et al. 2017; Kimes and Wirtz 2003). Initial studies also document a profit-generating potential of personalized pricing of 12% (Shiller 2014).

However, whether retailers can benefit from such profit-potentials depends on how they design their pricing approach. For instance, whether they only match competitor prices or account for consumer price elasticity[1] impacts the dynamic pricing approach's effectiveness (Fisher, Gallino, and Li 2018). In this chapter, I will discuss key decisions that retailers need to make.

Moreover, breaking with the norm of fixed prices provokes external and internal implementation challenges that retailers need to address. External challenges stem from potential adverse consumer reactions and stricter regulations (such as privacy regulations). Thus, retailers need to ensure that their pricing approach does not sacrifice long-term consumer relationships for short-term profits. Internal challenges can stem from a company's channel structure, its IT capabilities, and its cultural mindset.

1 Price elasticity relates a relative change in demand to a relative price change. A price elasticity value of -2.60 implies that a 1% decrease in price raises sales volume by 2.60%. If the absolute value of price elasticity is larger (smaller) than 1, consumers are price-sensitive (price-insensitive). Stated differently, higher absolute values of price elasticity imply that consumers react strongly to price changes.

For instance, retailers need to nurture a cultural mindset that is open to delegate pricing decisions to algorithms. Additionally, multichannel retailers need to develop a strategy for synchronizing pricing in their online and offline channels.

This chapter is based on state-of-the-art of academic knowledge and industry reports. Moreover, I will refer to in-depth interviews conducted by Vomberg, Lauer, and Weitkämper (2020). These interviews will provide further practical insights which enrich the discussion. Interviews were conducted with eleven online and multichannel retailers (referred to as R1-R11) as well as nine solution providers (i.e., companies that develop commercial dynamic pricing software, referred to as S1-S9) (Vomberg, Lauer, and Weitkämper 2020 offer a detailed sample description).

Background on Dynamic Pricing and Personalized Pricing

Research distinguishes online pricing approaches between whether they focus on posted-prices or price-discovery strategies. Posted-prices refer to the classical situation in which retailers set prices. In contrast, price-discovery methods are common in auction formats such as eBay or in the form of name- your-own-price mechanisms (Spann and Skiera 2020). This chapter will focus on posted-prices due to their predominance in the retail industry, reflecting practitioners' understanding (Vogelsang 2020).

Regarding posted-prices, online pricing approaches can be classified into dynamic pricing and personalized pricing (Haws and Bearden 2006; Kannan and Kopalle 2001). Dynamic pricing refers to price changes over time that are the same for all consumers. Personalized pricing refers to different prices that consumers pay at the exact moment in time.

I will discuss dynamic pricing and personalized pricing in greater detail and review the key terms in Table 1. I also like to note that companies can combine the two approaches. For instance, a company could flexibly adjust its prices during the day (i.e., dynamic pricing) and at the same time offer personalized discounts to some consumers (i.e., a form of personalized pricing).

Table 1. Concepts of Dynamic Pricing and Personalized Pricing Defined

Pricing Approach	Characteristics
Dynamic Pricing	Frequent price changes (often during the day) which can be substantial (extensive price range).
Personalized Pricing	
• Personalized Baseline Prices	Different consumers see different prices in the same online shop.
• Personalized Coupons	All consumers see the same (baseline) price in the same online shop. However, selected consumers receive special discounts.
• Price Steering	Consumers see different product results or the same products in a different order for the same search term. However, prices are the same.
• Location-based Pricing	Different consumers see different prices in the same online shop based on their geographical location.

Dynamic Pricing

Two key dimensions can describe dynamic pricing: frequency and range of price changes. Thereby, frequency refers to the number of price changes over a specific period (e.g., one month). For instance, media reports demonstrate that the price of a digital camera on Amazon.com changed 275 times within three days. Another study counted three million price changes on Amazon in Germany during one day.

The range can refer to the range of individual price changes or the range of prices within a specific time window (e.g., highest and lowest price in one week). A systematic review of online prices revealed that individual price changes could be substantial. The median absolute size of a price change is 11% in the U.S. (Gorodnichenko, Sherenirov, and Talavera 2018). Besides, prices can differ broadly within a specific period. For instance, industry observers noted that a digital camera's price changed within hours by up to 240% at Amazon.com.

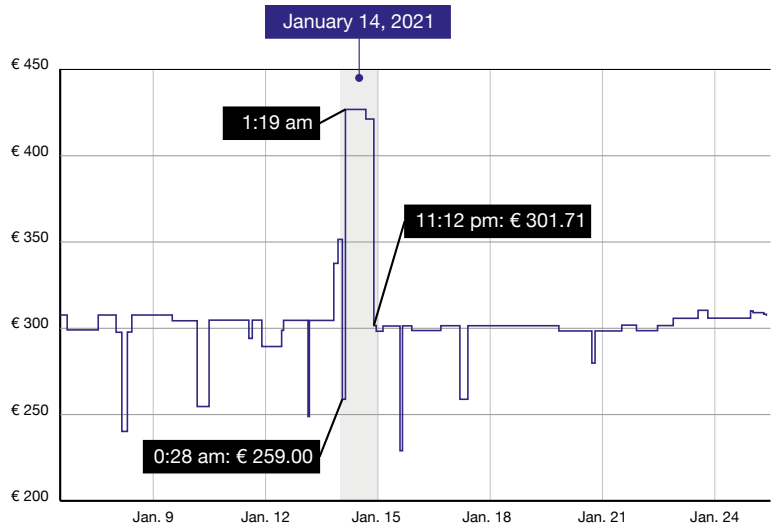

Figure 1. Dynamic Pricing of Samsung Galaxy Tablet (Tab A T510N 25, 54 cm, Tablet-PC (1.8 GHz Octa-Core, 3 GM RAM, 64 GB eMMc, Android 9.0, Black) on Amazon.de captured by Keepa

Since dynamic prices are identical for consumers, price crawlers can visualize price changes. For example, consumers can download for free the price crawler plug-in Keepa (https://keepa.com/), which tracks Amazon prices. Users will see the price developments for products on Amazon after they have installed the plug-in. Figure 1 demonstrates the evolution of prices for a Samsung Galaxy Table on Amazon.de. On January 14 (highlighted in grey), the price changed (frequency) around six times in a range from €259.00 (price at 0.28 am) to €427.67 (price at 1.19 am). Figure 1 illustrates why dynamic pricing can be compared to a slowed-down stock exchange.

Personalized Pricing

In contrast to dynamic pricing, personalized pricing requires some form of individualization. Companies can use the information that consumers leave behind as their "digital traces" to individualize prices. Specifically, companies can offer personalized baseline prices, personalized coupons, a personalized ranking of products on websites (referred to as price steering), or base prices on consumers' locations.

Personalized Baseline Prices

Retailers that employ personalized baseline prices show different prices to different consumers when consumers enter the website. Companies base those prices on some knowledge about the focal consumer's interests and behaviors.

Since retailers typically cannot observe a consumer's willingness-to-pay, retailers rely on indicators related to consumers' willingness-to-pay. Retailers may rely on information that consumers deliberately share with them. Retailers may use personal details that consumers enter when signing up in an online shop. Or, retailers use the information on consumers' willingness-to-pay that consumers reveal on "price wishlists" (Vogelsang 2020).

But retailers can also more "secretly" collect consumer information. Retailers can rely on cookie- data to acquire demographic information, track a consumer's browsing history, leverage information of the customer journey, consumer's operating system (e.g., Windows vs. iOS), or offer different prices based on whether consumers are using a smartphone, tablet, or PC. For instance, Mikians et al. (2012) observe that prices on Shoplet.com were on average 23% lower for users who came from a price comparison portal. Companies likely assume that consumers coming from price comparison portals are more price-sensitive (please note that such consumer tracking is likely problematic due to privacy regulations, see Section 0).

Personalized Coupons

Personalized prices, however, present only one way in which companies personalize prices for consumers. Targeting consumers with individualized coupons offers an alternative for personalized pricing. Customers receive individualized discounts based on their previous usage behavior. Companies implement such an approach, for example, through individualized newsletters, customer cards, or banners. For instance, the Dutch supermarket Albert Heijn regularly offers special discounts to consumers based on their loyalty card information.

Offering personalized coupons has several advantages over offering personalized prices. First, research indicates that consumers consider personalized coupons fairer than personalized prices (Weisstein, Monroe, and Kukar-Kinney 2013). A solution provider interviewed in the study by Vomberg, Lauer, and Weitkämper (2020) indicates the following:

> *S4: Online retailers don't work on price at all that often [...] because they are afraid that your perception of the price will be lower. That's why they primarily work through coupons. [...] And so online, as a retailer, you have the opportunity to say, "I'm going to keep the price level high and still make sure people convert by sprinkling in coupons."*

Second and relatedly, personalized coupons (in contrast to personalized base prices) create the impression among consumers to realize a bargain. A drawback, however, is that there is initial evidence that consumers can become used to receiving personalized

discounts. Consumers then perceive the absence of such coupons as an adverse event, comparable to a price increase (David et al. 2017).

Price Steering

Retailers can also employ price steering: Two consumers see different product results or the same products in a different order for the same search term. Search results presented earlier (e.g., on the first page) typically have a higher chance of being selected than products shown later. Thus, retailers can steer consumers towards buying higher-priced items.

For example, the online travel agency Orbitz Worldwide Inc. inferred that Apple Inc.'s Mac computer users would be willing to spend around 30% more a night on hotels. So Orbitz steered those consumers to costlier travel options: Mac users have seen more expensive options first, whereas non- Mac users have seen less costly alternatives (Mattioli 2012).

Retailers do not need only base price steering on the brand of the consumer's device. For example, retailers were reported to steer consumers to more expensive products based on whether those consumers visited in the past websites that carry expensive products or are geo-located to more wealthy postal codes (Iordanou et al. 2017). Experts also indicated that they engage in price steering in combination with personalized coupons. For instance, a retailer elaborated:

> *R5a: Cookies automatically detect it: you belong to the sports category, you use a Mac, which means you probably accept higher prices; therefore, I rank the products with a higher price first, and I give you 10% on the sports segment.*

Price steering differs, at least, in two critical aspects from other forms of personalized pricing. First, with price steering, all consumers can, in principle, end up paying the same price. Thus, to contrast this practice from the former ones, price steering is also referred to as search discrimination (Mikians et al. 2012). Second, price steering does not focus on one focal product but a set of products.

Location-based Pricing

Location-based pricing represents a basic form of personalized pricing. It refers to any price differences of products sold by the same retailer simultaneously between geographical locations. Considering users' locations might be profitable due to shipping costs considerations. And companies can use users' locations to account for areas with more (compared to less) competing retailers. I separately discuss this form since industry experts indicated that they considered to base prices on users' locations because they see profit-potential in location-based pricing (Vomberg, Lauer, and Weitkämper 2020).

Location-based pricing is a more common practice in offline markets. For instance, some drugstores in the U.S. charge different prices in their offline stores depending on their region (Cavallo 2017). However, there is also evidence of location-based pricing in online markets. Online retailers may rely on location information (e.g., IP addresses) to differ prices between countries. Studies observe online price differences between countries ranging from 21% (Mikians et al. 2012) up to 700% (Iordanou et al. 2017).

While studies observe location-based online price discrimination mostly between countries, there is also evidence of location-based pricing **within a country** (e.g., based on GPS data). Reports revealed that the office-retail supplier Staples.com displayed different prices to different people after estimating their locations. Staples.com might have also used information on the person's distance to the next competing offline store for setting the price (Valentino-DeVries, Singer-Vine, and Soltani 2012).

However, besides such initial evidence, industry experts note that location-based pricing is not frequently used within a country in online markets for offering different baseline prices or discounts for two reasons (Vomberg, Lauer, and Weitkämper 2020). First, regulations (such as from the German Federal Ministry of Justice and Consumer Protection) stand in the way of this approach. Second, experts also mentioned technological problems: in their opinion, GPS data would currently not be sufficiently accurate for location-based pricing.

Finally, findings from research question the usefulness of location-based pricing. The academic literature, in general, demonstrates that differentiation based on demographics such as location offers little value (Rossi, McCulloch, and Allenby 1996; Shiller 2014).

How Common Are Dynamic Pricing and Personalized Pricing in Business Practice?

After discussing the different forms of online pricing, a focal question is likely, how widespread are the different approaches in company practice. Naturally, with rapidly changing prices, it is challenging for researchers to attribute observed price differences to either form in practice. However, there are systematic investigations that largely attenuate such concerns.

In general, those studies hardly find evidence of personalized (baseline) prices (Hannak et al. 2014; Hupperich et al. 2018; Iordanou et al. 2017). Studies provide evidence on location-based pricing; however, it still qualifies it as a niche phenomenon (Hupperich et al. 2018; Iordanou et al. 2017). Most dominantly, retailers rely on price steering (Hannak et al. 2014). Thus, although personalized pricing received a lot of media attention and stimulated consumer outrage, there is hardly any evidence that many companies offer different baseline prices to large extents.

In contrast, there is much evidence that retailers employ dynamic pricing. Verbraucherzentrale Brandenburg (2020) tracked price developments of different products over five weeks for selected retailers. Results show that dynamic pricing is standard in various industries. For instance, the consumer electronics companies Media Markt and Conrad Electronic were observed to dynamically price 65% and 36% of their products, respectively. Similarly, dynamic pricing is observed among mail- order pharmacies such as Sanicare (the retailer prices 87% of its products dynamically) and DocMorris (59%), automotive accessory companies such as Auto-Teile-Unger (41%) and Tirendo (71%), and mail-order companies such as Otto (34%) and Zalando (49%).

Thus, the available evidence indicates that dynamic pricing occurs more frequently than personalized pricing in online markets — at least, as compared to personalized pricing in the form of different baseline prices. Expert opinions support this assessment.

> *S8: So, for Europe, individual pricing is the absolute exception. That has to be said quite clearly. The reason for this is a combination of technical limitations and a deliberate shying away from possible adverse effects.*

I expect that this trend will continue in the future. On the one hand, dynamic pricing will become more critical due to competitive pressures. On the other hand, ongoing privacy regulations (Section 0) presumably lower the speed at which personalized pricing spreads. Also, market developments such as Internet browsers (e.g., Microsoft Firefox) that disable cookies will restrict companies' personalized pricing opportunities. Given its prevalence, I will focus predominantly on how companies can implement dynamic pricing in the following.

Designing Dynamic Pricing Approaches

The previous paragraphs demonstrated that companies increasingly rely on dynamic pricing. While prior studies suggest that dynamic pricing increases profits, studies also show that the effect of dynamic pricing on profits depends on how companies implement dynamic pricing. In the following, I will discuss important decisions that retailers need to make. Specifically, I will provide guidance on IT implementation, selecting determinants for dynamic pricing, and product portfolio considerations. Table 2 summarizes the key issues.

Table 2. Key Decision Areas, Options, and Factors for Dynamic Pricing

Key Decision Areas	Characteri Key Decision Options and Factors stics
1. IT Implementation *"Which software should be used to implement dynamic pricing?"*	• Repricing software: meeting/beating competitor prices • Sophisticated pricing tools: Repricing functions + additional options (e.g., market experiments, inventory considerations)
2. Determinants for Dynamic Pricing *"Which determinants should inform dynamic pricing?"*	Important (not necessarily commonly used) • Competitor prices • Consumer price elasticity • Inventory level • Strategic considerations (e.g., service levels) Less important • Weather conditions • Time of the day/day of the week
3. Product Portfolio Considerations *"When are competitor prices more important for the dynamic pricing approach?"*	Competitor prices more critical for • Highly comparable products • National brands • Non-luxury brands • Key-value items
"Which product portfolio aspects need to be considered?"	• Price alignment between product variants • Role of the product (key-value item vs. no key- value item) • Product availability in different channels

IT implementation

In general, the implementation of dynamic pricing requires IT solutions. Companies can either rely on self-developed algorithms or use IT solutions that are offered on the market. Expert-interviews revealed that companies most dominantly rely on offered IT solutions since their development would require extensive efforts (e.g., programming and maintenance) (Vomberg, Lauer, and Weitkämper 2020). I classify externally developed solutions into Amazon repricing software, general repricing software, and more sophisticated pricing tools.

Amazon repricing software focuses on pricing on Amazon. Companies rely on this software to "win" the so-called buy box. In many instances, multiple companies sell the same product on Amazon.

In these cases, a proprietary Amazon algorithm determines whose company's product is visible to consumers in the buy box. Consumers can find offers from other companies on a different webpage. Winning the buy box is vital for companies; experts from Germany (Vomberg, Weitkämper, and Lauer 2020) and international observations (Chen, Mislove, and Wilson 2016) indicate that 82% of the purchases made on Amazon result from the buy box. Thus, retailers who do not win the buy box only close a sale in 18% of the cases.

Amazon repricing software lowers the retailer's price automatically until its price is below the competitor's price or until it reaches a pre-determined lower bound for the price. For the sake of completeness, I want to emphasize that the Amazon algorithm considers additional aspects such as shipping options and speed of delivery (Chen, Mislove, and Wilson 2016 investigate the algorithm in greater detail) to determine which offer will appear in the buy box. Therefore, as Figure 2 demonstrates, it is not necessarily the case that the company with the lowest price appears in the buy box. However, companies widely use Amazon repricing software since the price is typically the criterion that companies can influence most quickly.

Figure 2: Illustration of the buy box

General repricing software operates in the same manner as Amazon repricing software does. However, general repricing software also considers different prices, not only those offered on Amazon.

For instance, the software scraps competitor prices from price comparison tools such as Idealo or Google Shopping. A crucial decision that retailers need to make is to specify the relevant competitors and which products or product categories prices should be adjusted. Since there is no need to win the buy box on retailers' online shops, retailers can use the information to fully automate prices (just like selling on Amazon) or use the acquired knowledge to inform their (manual) pricing.

Finally, solution providers also offer more sophisticated pricing tools. In contrast to repricing tools which focus on competitor prices as the key determinant for dynamic pricing, sophisticated pricing tools consider additional information. For instance, those tools consider internal data such as inventory levels or compute optimal prices based on machine learning algorithms. Such sophisticated tools lower prices to beat competitors and conduct market experiments; systems will randomly raise prices to see and learn competitor and customer reactions (Mims 2017).

Determinants for dynamic pricing

Overall, the effectiveness of the dynamic pricing approach depends on which determinants companies include in their algorithm. I classify these determinants into market-related, customer- related, and company-related factors.

Market-related factors

Discussions with practitioners revealed that companies most dominantly rely on competitor prices to inform their dynamic pricing strategy. Experts interviews revealed that competitor prices are of focal importance, particularly in the online domain, since customers can easily compare prices on price comparison portals. Besides, tracking competitor prices is easy to achieve in the online domain (e.g., obtained from repricing tools).

> *S2: Experience shows that online retailers are exposed to such high competitive pressure that they have no choice but to respond to their competitors' prices.*

While research demonstrates the need to consider competitor prices, research also indicates that companies should incorporate consumer price sensitivities in their algorithms to enhance their returns from dynamic prices (Fisher, Gallino, and Li 2018). In this regard, media reports discuss the time of the day and the weather conditions as indicators or drivers of consumers' price sensitivity (Mersch and Merx 2015). This idea already dates back to the 1990s. The Coca-Cola Company experimented with raising prices in vending machines on hot days (Nicas 2015).

However, whether companies should consider such aspects likely depends on the environment in which they strive to sell their product. The time of the day or weather conditions might affect the prices of companies selling on online marketplaces. For instance, when more shoppers are on online market places (e.g., there are likely more online shoppers on Sunday evenings than on Monday mornings), it is imperative to win the buy box. However, experts indicated that time of the day effects or weather effects are less significant for companies that do not sell on marketplaces. While both likely impact the number of consumers in their online shops, these factors are unlikely to impact shoppers' price sensitivities (Vomberg, Lauer, and Weitkämper 2020).

Customer-related factors

Rather than relying on indicators such as the weather conditions or time of the day to infer consumers' price sensitivities, companies should directly incorporate consumers' price responses (BenMark et al. 2017). Companies could conduct randomized market-experiments to learn how much consumers will buy at different price points (Fisher, Gallino, and Li 2018). Alternatively, solution providers indicated that they infer customers' price sensitivities from real-time click and real-time transaction data (Vomberg, Lauer, and Weitkämper 2020). For instance, if an increasing number of customers clicks on the same article, the focal article's price might increase. This approach does not represent personalized pricing because it relies on aggregated customer data and increases prices for all customers.

Company-related factors

Retailers naturally also need to align their dynamic pricing approach with their internal goals. Companies can consider purchase prices and their inventory levels. For instance, fashion retailers may dynamically vary the prices of clothes during the season to avoid heavy discounts during end-of-season sales. Finally, companies can also consider the offered service level. Experts, for instance, indicate that consumers likely have a willingness-to-pay for higher service levels (Vomberg, Lauer, and Weitkämper 2020).

Product Portfolio Considerations

Moreover, companies need to decide which products they focus on for dynamic pricing and relatedly if they rely on different price-setting determinants. This decision depends on the comparability of the products, the brand, and whether the product constitutes a key-value item.

Comparability

The ease with which consumers can obtain prices for different products determines how competitor prices should inform the dynamic pricing approach. Products are typically easy to compare if they can be found on a search engine by typing in the product's name or the unique electronic article number (EAN). Among the products with a high degree of comparability are consumer electronics or national brands. Product categories with a low degree of comparability are, e.g., unique fashion items, furniture, or private brand products.

To lower the comparability between products, some news reports indicate that companies use different offline and online EANs to obfuscate price differences and prevent comparison. Research, however, does not find evidence that this technique is broadly applied (Cavallo 2017).

Brand

Dynamic pricing likely differs between private-label brands, national brands, and luxury brands. Private-label brands are developed and produced directly by a retailer or manufacturer and generally sold exclusively by that retailer. Those brands do not compete with other retailers, and consumers cannot search for them on price comparison portals. As a consequence, competitor prices are available for private-label brands. Private-label brands can thus optimize their pricing along with consumer price sensitivities and internal considerations. For instance, Amazon is reported to develop their private-label versions of competing products to reduce competitive pressures: e.g., while the price of Duracell AAA batteries fluctuates, the price of Amazon's private-label brand of AAA batteries is stable (Mims 2017).

In contrast, national brands often have easy-to-search names (e.g., Nike Airmax). Thus, they are highly comparable and therefore subject to intensive price pressure. Additionally, national brands are essential from a retailer's perspective, as they pull customers into the shop. For those national brands, typically, competitor prices should be considered.

Finally, experts claimed that luxury brands are less susceptible to price and therefore also competitor prices are less considered (Vomberg, Lauer, and Weitkämper 2020). For instance, a fashion retail chain manager explained that the manager excludes premium brands from any type of dynamic pricing. According to the manager, for luxury products, it is not necessary to compete on prices. Frequent price changes may even negatively impact the brand's high-quality image.

Key-value items

The dynamic pricing approach's design needs to consider individual products and their prices and the complete product portfolio, and the relative prices within the portfolio. For instance, retailers need to ensure that the pricing algorithm does not run counter to strategic pricing decisions. For example, prices of product variants (e.g., product in different colors) may need to be the same, and relative prices need to align (e.g., paint cans of larger volume cost more than smaller ones) (Natter et al. 2007).

Another important consideration is the role of key-value items (sometimes referred t as product heroes). In online channels, customers typically first choose which product to buy and then select the store that offers the best price. However, it is common for offline shoppers to purchase multiple products in one shopping trip. Consumers choose a store and then decide which products to buy. Key- value items pull customers into the store or initiate a purchase. Therefore, particularly for multichannel companies, this decision is essential.

For key-value items, retailers need to rely on competitive prices. Besides, key-value items drive customers' perceptions of the overall price image of the assortment. Interviews indicated that even retailers that only cautiously implement dynamic pricing systematically rely on competitive prices for key-value items. Likewise, most solution providers offer a particular module for key-value items, which calculates optimal prices more frequently than other products (e.g., BenMark 2017).

Challenges

Finally, managers need to overcome focal internal and external challenges when implementing their pricing approach. External challenges can result from adverse consumer reactions and privacy regulations. Internal challenges can result from the company's IT infrastructure, the simultaneous reliance on on- and offline channels, and cultural hurdles. Table 3 summarizes the discussion.

Table 3: Challenges to Dynamic Pricing and Personalized Pricing, Problem Description, and Potential Remedies

Challenge	Description	Remedies
External Challenges		
#1 Adverse Consumer Reactions	• Consumers consider dynamic pricing and personalized pricing unfair	• Complaint management approaches
#2 Privacy Regulations	• Regulations restrict usage of data needed for pricing approaches	• Focus on dynamic pricing • Obtain consumer consent
Internal Challenges		
#3 IT Implementation	• Companies lack the necessary IT infrastructure	• Rely on an externally developed software
#4 Multichannel Dynamic Pricing Dilemma	• Company may end up with different prices in on- and offline channels	• Restrict dynamic pricing to exclusive online assortment • Dynamic pricing only for key-value items • Lower frequency of price changes
#5 Cultural Changes	• Internal resistance to automate pricing decisions	• Align dynamic pricing algorithm with incentive schemes • Involve pricing managers in algorithm specifications • Step-wise rollout, followed by performance evaluations

Challenge #1: Adverse Consumer Reactions

A focal consideration is how consumers react to dynamic pricing. In this regard, the literature demonstrates that consumers perceive both dynamic pricing and personalized pricing as unfair. However, consumers react more negatively towards personalized pricing (Haws and Bearden 2006). Personalized pricing may lower the consumer's trust in the retailer (e.g., Gabarino and Lee 2003) and a consumer's repurchase intentions (Gabarino and Maxwell 2010). Importantly, not only price- disadvantaged consumers react negatively. Consumers who realize a better price than other consumers also tend to display adverse reactions (e.g., guilt), particularly if they like the consumers who paid higher prices (Gelbrich 2011).

To avoid negative consequences, retailers try to resolve these tensions provoked by consumer evaluation by concealing their pricing approach. While not all consumers are currently aware of dynamic pricing, I expect that concealing is unlikely to be a long-lasting strategy. Transparency of dynamic pricing and personalized pricing is likely to increase due to media reports exposing these techniques to broad audiences. Moreover, the popularity of price trackers has grown (e.g., Keepa or CamelCamelCamel); 4 million consumers visit Keepa per month on average (WebsiteIQ 2022). Thus, retailers may establish complaint management approaches. Retailers could offer special discounts for consumers who note differences in prices.

Challenge #2: Privacy Regulations

Recent regulations such as the General Data Protection Regulation (GDPR enacted in 2018) or the California Consumer Privacy Act (CCPA enacted in 2020) restrict consumer/user data usage and require companies to disclose all of their data processing activities. Besides, in many cases (e.g., GDPR), companies are only allowed to process consumer data after consumers gave their consent. Notably, any information that directly or indirectly relates to a person qualifies as personal data, or stated differently, any identifier connected to an individual qualifies as personal data. Instead of only focusing on the consumers' names and addresses according to privacy regulations, IP addresses or cookie identifiers also qualify as personal data (Bleier, Goldfarb, and Tucker 2020).

Such regulations affect dynamic pricing to a lesser extent, as dynamic pricing typically relies on competitor-related and company-internal information and only analyzes aggregate consumer data[2]. However, personalized pricing requires that companies

2 For the sake of completeness, I emphasize that also the analysis of aggregate data can conflict with privacy regulations. If companies aggregate individual personal data, this requires either that consumers gave their consent or that there is a legitimate interest in processing the data.

transparently communicate to consumers that they use their data for personalized pricing and request consumer consent (Spann and Skiera 2020). Experts raise severe doubts that consumers will provide their consent for personalized pricing (Borgesius and Poort 2017).

Importantly, GDPR also rules out that retailers process certain kinds of data (also referred to as "sensitive data") in general. Thus, companies are not allowed to perform personalized pricing on such sensitive data. Sensitive data are "personal data revealing racial or ethnic origin, political opinions, religious beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation" (Article 9(1) GDPR).

Challenge #3: IT Implementation

Technological developments such as the availability of real-time customer and competitor data and the potential automation of pricing decisions have enabled dynamic pricing. At the same time, technological hurdles represent a reason why companies shy away from dynamic pricing. Typically, small- and medium-sized companies do not have sufficiently strong IT capabilities to develop a dynamic pricing solution. However, those companies can still rely on external software solutions.

Technological hurdles are even more pressing in the context of personalized pricing. The experts stated that customer-specific prices would require individual landing pages, which would mean a substantial IT outlay. Furthermore, identifying customers via different end devices (e.g., laptop, smartphone) would represent a hurdle. Customers would notice different prices when changing the end device. However, the experts agree that large and innovative online stores with sufficient IT capability can overcome these problems (Vomberg, Lauer, and Weitkämper 2020).

> *S4: "Everyone gets their own price." Retailers can't do that at all. [...] Because that would mean that every person gets their own landing page. That's a) a server power that most stores can't even afford, and b) a considerable effort.*

Challenge #4: Multichannel Dynamic Pricing Dilemma

Notably, for multichannel retailers (i.e., simultaneous usage of online and offline channels), dynamic pricing can constitute a crucial challenge. Multichannel companies need to make two decisions. First, they need to decide whether they aim for price consistency or differentiation between online and offline channels. Second, they need to determine how they implement dynamic pricing.

First, the consumer electronics company Conrad Electronic serves as an example of a company that transparently differentiated prices between their online and offline channels. Conrad Electronic communicated a store price and a lower online price on its website for some time

In contrast to the example above, a systematic large-scale empirical investigation of online and offline prices from multichannel retailers from different countries revealed that multichannel retailers' predominantly (72% of the cases) set the same price in their online and offline channels (Cavallo 2017). But there are differences between industries: drugstores and office-product retailers have the lowest share of identical prices, with 38 percent and 25 percent, respectively, while for consumer electronics and clothing retailers, these numbers rise to 83 percent and 92 percent, respectively.

Overall, results indicate that companies set prices equally between channels. I am only aware of one study that systematically investigates sales volume implications and consumer reactions to online- offline-price differentiation (Homburg, Lauer, and Vomberg 2019). This study shows that, in general, companies can hardly realize offline price premiums. Only for high-priced items and take-away items, consumers accept higher prices. Consumers consider buying high-priced items risky and most likely have more confidence in offline channels. For take-away items, consumers are typically not price-sensitive. However, in between these two extremes, the results show no potential for offline price premiums.

Second, although companies typically strive for a price-consistency strategy, competitive online pressures can force retailers to employ dynamic pricing and accept temporary price differences between online and offline channels.

Companies can resolve these tensions in different ways. Companies that do not sell all products in both their online and offline channels can focus on dynamic pricing only for the online channel and/or adopt dynamic pricing only for key-value items. Also, since the frequency of price changes is typically lower in offline channels, companies may reduce the frequency of price changes in the online channels.

However, I also want to add that some multichannel retailers state that potential threats from multichannel dynamic pricing outweigh its potential gains and, therefore, abolished dynamic pricing.

R6: We just discontinued the topic of dynamic pricing last week. [...] The fact is that dynamic pricing offline, and online is not possible as a multichannel provider. That means Dynamic Pricing can only work well for pure-online players! That's actually what it's intended for, and it's a pretty perfect tool for that!

Challenge #5: Cultural Changes

The implementation of dynamic pricing requires that companies delegate pricing decisions for which humans have been in charge to algorithms. While pricing managers or the procurement department traditionally set prices, using an automated dynamic pricing algorithm implies a loss of control of former pricing managers. Naturally, this requires that many companies go through significant cultural changes. One retailer notes the following:

R3: It's not just a question of technology ..., but also has to do with change and cultural change...That requires that you become a bit more agile... So it's a question of mentality. That's also what dynamic pricing is about - it's part of the big picture, the extent to which a company is willing to adapt and radically introduce processes and changes in the company. So Dynamic Pricing is not just software [...]; it's usually a fundamental change in the way you've been doing things.

Implementing cultural changes requires that companies align formal and informal elements (Vomberg, Homburg, and Gwinner 2020). Regarding formal elements, managers, for example, need to make sure that dynamic pricing algorithms align with incentive schemes. Natter et al. (2007) document a case in which resistance to dynamic pricing was spurred since the dynamic pricing algorithm maximized profits, while sales managers' variable compensation depended on sales volume targets.

Regarding informal elements, managers need to create a cultural mindset that is open to pricing automation. This likely represents a challenging task since, in general, people exhibit an aversion to algorithms. Such an aversion can present a particular concern if managers perceive the dynamic pricing algorithm as a "black box," that is if managers cannot understand how the algorithm works and why it suggests a focal price. In such a situation, it becomes likely that managers will reject the algorithm entirely, or at least, not trust its results.

To lower pricing managers' aversion, managers should involve them in selecting and configuring the dynamic pricing algorithm. Research documents that such involvement can lower aversion to algorithms (Dietvorst, Simmons, and Massey 2016).

Moreover, companies should demonstrate to pricing managers the need and returns for dynamic pricing. For instance, demonstrating volatility in competitor prices may overcome resistance. Also, managers could communicate potential returns to automated pricing (e.g., Karlinsky-Shichor and Netzer [2019] show that a combination of automatic pricing and human judgment can result in increased performance). Managers could roll out dynamic pricing for a subset of products and jointly evaluate the effectiveness with pricing managers (Natter et al. 2007).

Concluding Remarks

Pricing decisions make a significant contribution to corporate success (Homburg et al. 2015). The ongoing digitalization has increased access for firms to information on their competitors and customers and allows companies to automate their pricing. These developments have resulted in two novel pricing approaches: dynamic pricing and personalized pricing (Figure 4 summarizes the discussion). While those pricing approaches are typically associated with large online retailers, small- and medium-sized companies can equally apply them. Industry experts expect that dynamic pricing, in general, will become the norm in online markets.

Dynamic pricing can contribute to company success. However, to unfold its full profit-creating potential, retailers need to design their dynamic pricing approach carefully. Besides, retailers need to overcome challenges when implementing a dynamic pricing approach. Based on the current state of academic research and interviews with managers, I discussed focal decisions managers need to make on how to design their dynamic pricing approach. In addition, I discussed how retailers could address focal implementation challenges. Overall this chapter guides managers to unlock hidden profits with their dynamic pricing approach.

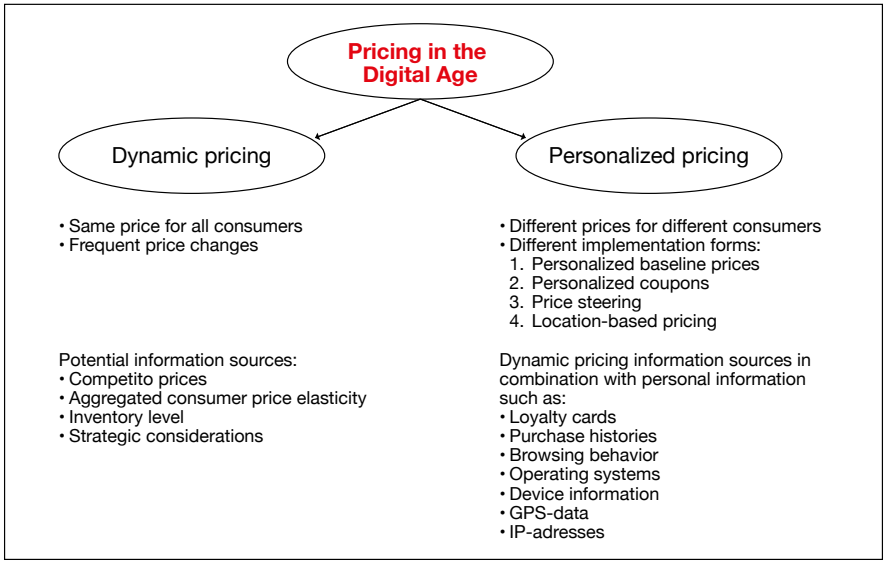

Figure 4. Summarizing overview of dynamic and personalized pricing

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#10

How Digital Transformation Impacts Consumer Behaviour

Scan the QR for the animation of this chapter

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Groningen Digital Business Centre (GDBC) - Pubished March 2022

This chapter discusses digital transformation from a consumer perspective. The digitalization affects consumers since the ways of communicating, gathering, and exchanging information about products and/or services, and obtaining and consuming them, drastically changed. Think of buying online, easily searching online and comparing product offerings from different suppliers and writing & reading online reviews. Also, consumers are empowered by new media to promote and distribute their own offers. Hence, this also affected firms, as they had to change their business models to adapt to these changing needs. This led to multi-channel and finally omni-channel management.

Digitalization and new media have made it possible for consumers to not only be passive recipients of firm communication, but also to actively communicate with firms and with each other. So, from unidirectional firm to consumer communication, communication becomes multidirectional.
However, traditional marketing communication tools have not disappeared and remain relevant. Different studies have shown that also in this new digitalized world, traditional media remains an effective medium to influence consumers, next to new media.

The chapter further discusses some examples from practice. For example, At DVJ we developed a new KPI that represents contacts that brands have with consumers. This so-called RPS enables us to compare different media directly with each other. The chapter concludes with different success stories of firms that succeed in utilizing digitalization to their advantage and surprise consumers every day.

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Lisan Lesscher is a Senior Research Expert at DVJ Insights. She obtained her PhD at the University of Groningen, department of Marketing. Her research focused on two prominent challenges for marketing introduced with the digitalization: (1) management of different (online and offline) communication channels, (2) management of different sales channels. She published among others in the *International Journal of Research in Marketing*.

The Idea in brief

The Issue	The Response	The Bottom Line
What is digital transformation from a consumer perspective and how does the digital transformation impact consumer behaviour?	Digital transformation has far-reaching impact on consumers as well as business and marketing. The digitalization affects consumers since the ways of communicating, gathering, and exchanging information about products and/or services, and obtaining and consuming them, drastically changed.	Digital transformation highly impacted consumer behaviour. As an example, the communication becomes multidirectional empowering consumers to write online reviews or distribute their own offers. This also affected firms, as they had to change their business models to adapt to these changing needs. Finally, this chapter highlights some examples of firms that do considerably well on this.

Introduction

"Clearly, the thing that's transforming is not the technology — it's the technology that is transforming you." — Jeanne W. Ross of MIT Sloan's Center for Information Systems Research

We are living in a digital era in which we cannot imagine a world without technology anymore. Think of a regular day: The alarm of my smartphone wakes me. After taking a shower, I have breakfast while updating myself with news in the world as well as checking updates on social media and my personal e-mail. After a short walk and coffee, I open my work laptop from my home office, check my e-mail, have some video calls, and work remotely through the VPN connection. My calendar tells me I have a client meeting. Happy to be able to meet physically, I put on Google maps to navigate me. While driving, I make some other calls. Being at home again I finish work and start cooking. I realise I forgot something and quickly order it from one of the online grocers that deliver at home within 10 minutes. I also notice that the fridge is almost empty anyway and order the weekly groceries online at my preferred supermarket. In the evening, I watch Netflix while at the same time chatting with a friend over WhatsApp and checking social media. I also see a nice offer for new shoes and directly order them as well. In bed I either read a book on my e-reader or listen to a podcast. Then I turn on my alarm on my smartphone, waiting for what tomorrow will bring.

Imagine your daily life without digital technology. So, not being able to communicate digitally, search for information online, check the social networks. We can hardly imagine living without these technologies anymore, and as the quote of Jeanne W. Ross indicates, the digital transformation affected and is still affecting all of us (as consumers).

This chapter focuses on digital transformation from a consumer perspective. Therefore, it is first important to know how we define digital transformation. Subsequently, we review how digital transformation has impacted and still impacts consumer behaviour. This chapter would not be complete without including the firm perspective, as digital transformation also impacts the way consumers interact and communicate with firms. Then, we talk about challenges in digital transformation and consumer behaviour. We finish with success stories in which firms very well understand digital transformation and consumers' needs.

What is digital transformation from a consumer perspective?

The short story of a 'regular day in my life' from the introduction shows that every day is filled with technology, digital tools, and being always connected and online. Furthermore, being connected also means it is much easier to buy online or be in contact with firms via e-mail or social media. And, of course, the corona pandemic caused many more developments digitally at a rapid peace. It showed us that many companies and consumers had to use new technologies and shift to online. Not only for buying products, but also for being able to work or attend school or university. Of course, this offers enormous opportunities for some companies, but also challenges for others.

Overall, the digital era allowed us to move online (even further) and continue working and interacting with one another. This was hard to imagine compared to a quarter of a century ago when it was nearly impossible to imagine living with these digital technologies. The ongoing digitalization started with the advent of digital technologies. The entrance of these technologies interrupted a lot of our existing systems, forcing business and marketing to transform drastically. Offset by the introduction and worldwide adoption

of the Internet and World Wide Web in the late 90's of the last century in addition to the entrance of an increasing number of accompanying technologies (e.g., smartphones, online payment systems), the development of e-commerce reinforced. The term digital marketing also developed and evolved over time. Starting as a specific term describing the use of digital channels for the marketing of products and/or services, it evolved into an umbrella term as defined by Kannan and Li (2017, p. 3): "an adaptive, technology-enabled process by which firms collaborate with customers and partners to jointly create, communicate, deliver, and sustain value for all stakeholders." The fast growth of digital marketing attracted much attention from marketing researchers with a main interest into exploring how the expansion of new channels influences consumers' purchase behaviour and strategies (for a review, see Kannan and Li, 2017).

Overall, the digital transformation has far-reaching impact on consumers on the one hand, and business and marketing on the other hand. It provides both firms and consumers with several opportunities, but also complexity and new challenges, for example of channel management. What do we currently know about the impact of digital transformation on consumer behaviour? And how does digital transformation impact the way firms and consumers communicate? What are challenges related to digital transformation and what do we not know (yet)? What are success stories of firms that are able to utilise the digitalisation to their and consumers' advantage?

How does digital transformation affect consumer behaviour?

The digitalization affects consumers since the ways of communicating, gathering, and exchanging information about products and/or services, and obtaining and consuming them, drastically changed (e.g., Hennig-Thurau et al., 2010). Of course, one can think of buying online, easily searching online and comparing product offerings from different suppliers, writing, and reading online reviews to be informed, or engaging in showrooming, which is gathering information offline about certain products and finally buying online (Gensler et al., 2017). Also, consumers are empowered by the new media to promote and distribute their own offers. You can think of consumers as retailers on eBay or the Dutch Marktplaats, or consumers set up their little 'shops' on Facebook or Instagram. So, this makes it possible to buy practically everywhere, from everyone, at any time. The recent corona pandemic and lockdowns increased the amount people buy online even more.

DVJ Insights conducted several studies during the corona pandemic and lockdowns, and we could show that consumers started to buy more online (DVJ Insights, covid updates 2021; emerce.nl 2020). People also started to buy certain things more and other things less. Think about chewing gum and deodorant that is bought less, whereas chocolate and liquorice is bought more. People also bought more games, sports equipment, bicycles, or other sporting equipment for outside, home office supplies and hardware, hair dye products, and post cards (RTL, 2021).

After the introduction of digital technologies, a plethora of new media have made their entrance, which gives consumers many opportunities to become more active, connected, empowered, and informed (e.g., Lamberton & Stephen, 2016; Verhoef et al., 2017). In addition to that, consumers are provided with wide-ranging options to provide information to others and make it quite easy and convenient to talk to each other online (Hennig-Thurau et al., 2010). For example, digital technologies enable consumers to help other consumers by sharing product reviews or to co-create value by designing and/or customizing products (e.g., Beckers, Van Doorn, and Verhoef, 2018).

Besides influencing consumers, the digitalization also affected business and marketing – also (partly) due to its effect on consumers bringing about the need for change in business and marketing (e.g., consumer centric perspective). The (new) digital technologies change all aspects within firms, from their activities to the processes, systems, and structures. Consequently, business models have also changed, and continue to change, based on the digital developments. A new type of business model was introduced: the digital business model. Verhoef and Bijmolt (2019) define the digital business model as "situations where digital technologies have fundamentally affected the way a firm structures and carries out its business and thereby creates value for customers, the firm itself, and its partners". This applies to how and where businesses sell their products or services to consumers, but also how they communicate with their consumers. With the entrance of new distribution or communications channels – which allows consumers to buy practically everywhere, from everyone, at any time – businesses are faced with opportunities and challenges as well. Before the digital transformation, the channels available for firms and consumers to purchase products and/or services were limited and geographically bound. The online channels, which made their entrance, co-existed with the offline channels. With all changes due to the digital transformation, retailers initiated multichannel strategies.

At first, these multichannel strategies mainly dealt with whether the existing channel mix should be expanded with new channels (e.g., Deleersnyder et al., 2002). This decision applies not only to the traditional brick-and-mortar firms, but also to new online-only

firms (Avery et al., 2012). Over time, the scope of multichannel retailing extended to, for example, the management of customers across multiple channels (e.g., Neslin et al., 2006). A great influence in the development of research on multichannel retailing has been the article of Neslin et al. (2006, p. 96), defining multichannel customer management as "the design, deployment, coordination, and evaluation of channels to enhance customer value through effective customer acquisition, retention, and development." Important to note is that channels are now considered as a medium for consumers and firms to interact – focusing on channels providing two-way interaction instead of the former one-way interaction of traditional marketing.

Multichannel strategies have mostly been developed and managed separately within firms (Verhoef, 2012), with only limited integration of the different channels. The entrance of new online and even mobile channels resulted in another disruptive change to retailing (Rigby, 2011). Not only could more channels be studied, but also the natural boundaries between them started to disappear and the different channels became blurred. "Channels are interchangeably and seamlessly used during the search and purchase process, and it is difficult or virtually impossible for firms to control this usage" (Verhoef, Kannan, and Inman, 2015, p. 175). This is termed omni-channel management, which is defined as "the synergetic management of the numerous available channels and customer touchpoints, in such a way that the customer experience across channels and the performance over channels is optimized" (Verhoef, Kannan, and Inman, 2015, p. 176). Verhoef, Kannan and Inman (2015) suggest that omni-channel management is put in place for multichannel management.

How does digital transformation affect consumer-firm interaction?

One of the things that has changed consumer-firm communication tremendously is the fact that new media has come up in recent years. The characteristics of these media are that they are digital, pro- active, visible for others, real-time and memorized, ubiquitous, they can be reached anywhere at any time through mobile devices and can be used to participate in networks (Hennig-Thurau et al., 2010).

These new media have made it possible for consumers to not only be passive recipients of firm communication, but also to actively communicate with firms and with each other. Hennig-Thurau et al. (2010) nicely visualize this in their 'pinball framework'. On one side we have the company, which reaches consumers via their marketing communications. Customers can in turn buy from the company. They can also talk to other consumers about their experiences through new media.

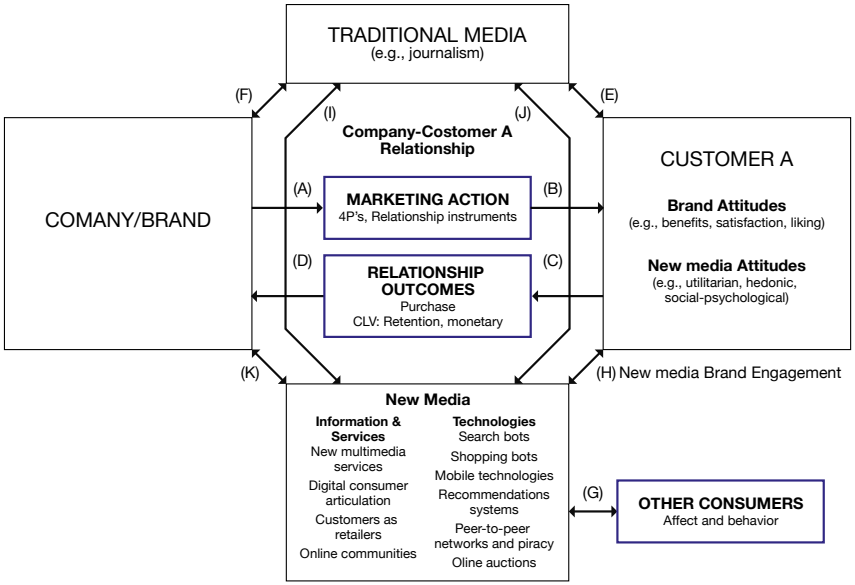

Figure 1. Pinball framework. Source: Hennig-Thurau et al. (2010)

In this new digital world, the traditional marketing communication tools have not disappeared and remain relevant (Forbes, 2017) and are still widely applied by businesses (Statistica, 2019). However, research into the effectiveness of traditional marketing communication tools, such as direct mailing, is scant in the online environment. Questions that remain unanswered entail how the offline communication affects consumer responses in the digital world and how they interact with digital marketing communication tools. Lesscher, Lobschat and Verhoef (2021) find support that direct mailing still serves as an effective marketing tool, both by itself and in combination with digital marketing. They reveal that direct mailing significantly affects online consumer responses (i.e., online search and clicking behaviour), in support of cross-channel effects of direct mailing. Furthermore, direct mailing is shown to be effective throughout the (online) purchase funnel, both directly and indirectly, with a positive net sales effect. Lastly, they show a positive synergy between the traditional and digital communication tools (i.e., direct mailing and display advertising), which implies offline and online marketing communication complement each other.

Another study of de Vries, Gensler, and Leeflang (2017) also showed that traditional advertising is still highly effective, also when considering new media. More specifically, the results indicate that traditional advertising is the most effective way to influence consumers' awareness, consideration, and customer acquisition (in a telco setting). Firm-to-consumer social messages (brand posts on social media) and the impressions generated through these messages are also effective in stimulating consideration and acquisitions beyond traditional advertising. Consumer-to-consumer social messages (for example, Tweets), instead, are effective in creating preference and acquisitions. Moreover, interrelations among traditional advertising, F2C impressions, and C2C social messages exist. Their study provides additional evidence that traditional advertising spurs volume of C2C social messages (Fossen and Schweidel, 2017). Furthermore, traditional advertising generates more favourable C2C social messages. Finally, there is evidence for feedback effects. These findings illustrate the complexity of the relations among the firm's "echoverse" and outcome variables and highlight the need for methodological approaches that can capture those relations to effectively orchestrate a firm's efforts to build a brand and business (Hewett et al., 2016).

Another substantial amount of research is devoted to the effects of the interactions among consumers on new media for business results. Because of digitalization, consumers are now able to talk to each other, for example by writing online reviews. The fact that consumers can do so, has serious consequences for firms, as they are not very well able to control what consumers will write. And it definitely affects firms. A substantial amount of research is devoted to the link between the volume, valence, and variance of eWOM (mainly online reviews) and business results, such as sales and stock prices. A meta-analysis on the effects of online product reviews on sales concludes that the mean review valence elasticity is .69 whereas the mean review volume elasticity is .35, indicating that valence is more important than volume for evoking sales (Babic Rosario et al., 2016; Floyd et al., 2014).

At DVJ Insights, we also have access to lots of information on media deployment (both traditional and new) and brand metrics as well as sales figures for different brands. For them, we also examine what their optimal media spending level would be. We do this in a very innovative way as we developed our own KPI to examine the effects of media on different outcome measures. We believe this is necessary to do, for four reasons:

1. Media differ in their impact: The unique characteristics of each medium make it likely that media channels vary in the likelihood of reaching consumers and making them remember the campaign. For example, viewing an advertisement in the cinema is likely to have a different impact than an ad on a news website.
2. Ad formats matter: Within each channel, the specific format of ads drives their effectiveness. For example, in online advertising, we know that the likelihood of seeing a homepage take- over is much higher than seeing a skyscraper banner.
3. Ads may linger in memory: Merely visually inspecting the effects of weekly investments on relevant KPIs in that same week implies that weeks without media investments should not impact consumers. However, we know that advertising effects show a gradual decrease of impact. The size of the decay is dependent on the history and awareness of a brand.
4. Creative execution is pivotal: The creative execution plays a massive role in the effectiveness of advertising. ln addition to influencing consumers' overall feelings in response to an ad, we also know that the ad itself impacts whether consumers are attentive to an ad. Ads that are not noticed will not have an effect.

Therefore, at DVJ Insights we work with a KPI that represents all contacts better than spendings, the Reality Performance Score (RPS). RPS represents the real number of contacts that brands have with consumers. RPS compares each media to another and evaluates them. It weighs each media differently based on the opportunity people must engage with that medium and notice the ad. It differs if you are for instance watching a video online, or at the cinema. On top of that, RPS looks at the decay effect because of advertising memory. RPS looks back at the number of contacts from last week and ads a part of that to this week. It is an intelligent algorithm. Finally, we have integrated the possibility to use the strength of the creative as well. As a result, RPS is the first real KPI that represents the total sum of all media. We conducted a validation study and found that RPS is a better predictor of effect than expenditures or GRPs. What is unique about this measure is that it can consider all different types of media, online, digital, or offline and traditional, and subsequently link this to different outcome measures. What we for example do for our clients, is determine whether their spending levels can have an effect or if they are spending too much (see for an illustration Figure 2). Are you able to stay within your bandwidth?

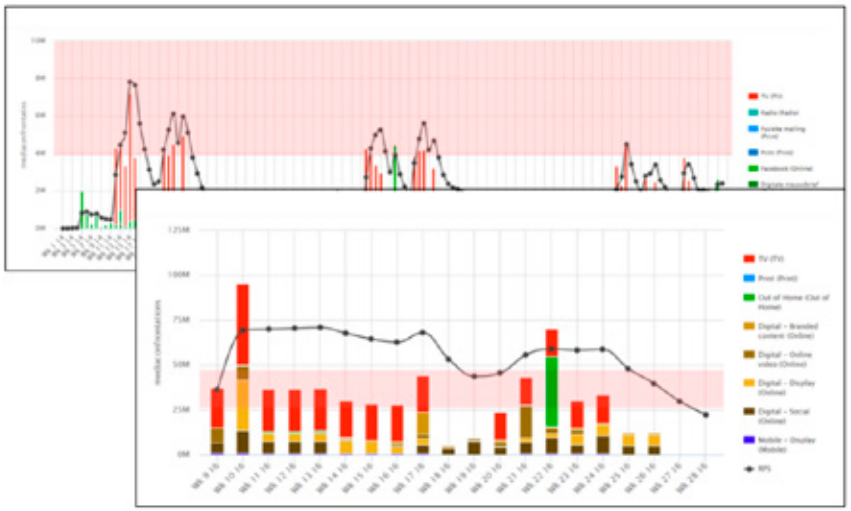

Figure 2. Example of bandwidth analysis

Challenges related to digital transformation for consumers

In this paragraph we will discuss some challenges related to digital transformation. Challenges related to digital transformation surround new media and channels, analytics/big data, and business models (Leeflang et al., 2014).

New media and channels

A challenge for firms is what happens to their traditional media and channels in the new digital world. Research starts to look into this matter, but there remains much to uncover. How can you best combine or even integrate online and offline marketing communication channels? Traditional marketing communication tools, such as direct mailing, can also be integrated with digital marketing activities. Think about direct mailing (as studied by Lesscher et al., 2021), a personal link or QR code can be included allowing firms to track the response to the direct mailing more accurately. This use of channels interchangeably and seamlessly (e.g., omni-channel management, as discussed in section 2) offers firms opportunities, but also challenges. It would be useful for companies to consider how they can integrate their channels in such a way that they can offer the most value to their customers and, at the same time, capture the most value. Another question that arises is which types of consumers (segments) respond in what way to which combinations of marketing communication. This will help firms to properly target the right communication to the right audience.

Analytics/big data

What is a big challenge for firms, is the enormous amount of customer data that becomes available and that is gathered within organisations. We found in our annual Brand Growth Study of 2021 that was centred around the theme data-driven decision making, that 58% of marketers and insights managers feel that organisations have too much data and don't know how to use it properly (https://www.dvj-insights.com/brandgrowth-study-2021/). We also asked marketers and insights managers about challenges regarding working with data for making important marketing decisions. The most important challenges do not relate to the data itself – that is something that is generally widely available – but they relate to capabilities such as having the right people, finding the right tools and software as well as prioritising and timing of data and results/insights.

Business models

A final challenge concerns the business models for firms. As shared, digitalization also affected businesses. On the one hand, this is due to the influence of digitalization on consumers bringing about the need for change in business (e.g., consumer centric perspective). On the other hand, the new digital technologies alter all aspects within firms, such as their processes, systems, structures as well as their activities. This led to the new business model termed digital business model (e.g., Verhoef and Bijmolt, 2019). With the introduction of new channels – either for distribution or communication – consumers can buy everywhere, from everyone, at any time. This provides opportunities and challenges to firms. How to best structure your firm to create value for customers, the firm itself, and its partners.

Success stories

Digital technologies have paved the way for new ways to do business or research. In this paragraph we will discuss some examples of successful cases. Some come from own experience/observations in the market, some come from our clients through conducting research on a certain topic to help them grow.

There are many disruptive incumbents that target niches in the market. Think of the Dutch online supermarket Picnic that was quite disruptive for the Dutch supermarket landscape. Picnic operates only with distribution centres and directly delivers to customers who can order via an app. They deliver with small electric cars right onto your doormat, always with a smile. In this way, they do not need physical stores anymore. At the same time, they know a lot about their customers, since all the data is in the app. Their customer service is excellent; if something is amiss with your groceries, you get it refunded or for free next time or you get an alternative product. Also, when they deliver in the evening, they knock on the door if they know that you have small kids. It are those small gestures that make such a difference. Online retailers/grocers are perfect for those who have little time to do groceries (for example, families with young children), or who do not like to do grocery shopping or who are not able to go grocery shopping (think of being in quarantine, or physically unable to go shopping). Another service Picnic is offering is the returning of packages from DHL, if they fit in their vans. Also, disruptive in retail are parties like Gorillas who can deliver within 10 minutes. These examples show that there are some firms that were able to dive into a niche that captures consumers needs in the retail sector and were able to do so very successfully.

Another nice example of using technology in another way for a traditional business, is the example of a financial services provider who wanted to introduce advice through video call (https://www.dvj- insights.com/Cases/advice-over-a-video-call/). Consumers do not always want to visit a company in person, nor have the time, or the opportunity these days, to get advice. To respond to this trend and deal with the changing times in an agile way, it is interesting for companies to explore new techniques for their services. During the corona crisis, this has become even more relevant. Our client already conducted a number of pilots with financial advice through video calls. Because these pilots were successful, the client developed a proposition regarding video advice, which needs to be tested among a broad Dutch target group. Therefore, we have tested new propositions

and found out how it resonates among potential clients. The results show that there is indeed an interest in video advice. Positive associations are related to ease and speed, while the most common negative association is the impersonal element. The flexibility of a video call is the most appealing element of the proposition. The perception of detachment, on the other hand, is the greatest barrier. The client has introduced the proposition successfully, well before the corona crisis began. But the corona crisis has most likely made video advice a greater success and necessity.

Another success story relates to the way technology can help and improve the way we can conduct consumer research (https://www.dvj-insights.com/Cases/leveraging-ai-to-uncover-ceps/). For example, at DVJ Insights, we are now using artificial intelligence to learn more and better from our qualitative response. We applied this to identify Category Entry Points (CEPs) for one of our clients. Knowing what makes people think of the brands in the category forms a source of inspiration for products and messaging. We conducted a large-scale CEP Exploration study. To identify growth opportunities for the brand, we took a two-step approach. In the first stage, we sized and identified Category Entry Points based on a unique mix of qualitative and quantitative techniques and analyses: We used Storytelling to uncover the different moments the category is used. We let consumers tell us their story: where they used a product, when it happened, for what reason, in which context, for which purpose and so on. Via the DVJ Storytelling technique, we gained insight into relevant CEP consumer experiences. In the quantitative analysis, we asked respondents to classify their own responses in different ways, such as positive-negative, relevancy and willingness to share. Using AI-powered text analytics, we can extract meaning out of large volumes of unstructured text and translate this into meaningful quantitative data. This data can then be used to uncover trends, patterns, and insights. By leveraging Text analytics on the stories, we identified similarities and differences across categories and gender. In the second stage, we zoomed in further on the newly found CEPs and measured the mental market share and mental penetration of the brand among consumers. We also measured the position of the brand's main competitors, as well as scores within each of those CEPs. This helps brands to understand where to play and how to win. By leveraging AI-based topic modelling on the collected consumer stories, we were not only able to identify the most important CEPs per category but could also pinpoint differences by gender in terms of CEP-hierarchy. The stories provided further inspiration on how to best bring each of the CEPs to life in the language of the consumer. The unique mix of qualitative and quantitative techniques with AI-powered storytelling analysis helped the brand to identify CEPs in five different categories with clear distinctions at a category and gender level.

Conclusion

Overall, the digital transformation has far-reaching impact on consumers on the one hand, and business and marketing on the other hand. Providing firms and consumers with several opportunities, it additionally also provides complexity and new challenges. This chapter discussed how digital transformation has affected consumer behaviour. Changes have been large as so many new venue have opened up for consumers to buy or sell products and services. Digital transformation also affected consumer-firm interactions to a large extent. Whereas the interaction between firms and consumers used to be one-way, nowadays it is bi- (or maybe even multi-) directional. This has impact on the effectiveness of a firm's communications to consumers via different channels. Research showed, however, that traditional media still is effective, together with new media.
Challenges regarding digital transformation surround new media and channels, analytics/ big data and business models. There are also firms that are able to employ digitalisation and use it as their advantage, think about newcomers in retail such as full online grocers or established firms that are able to utilize new media and technologies in their advance. Finally, in marketing research, we are also able to utilize new technologies and dive deeper into our qualitative data by using AI.

So, to conclude, digitalisation has caused many changes last years, for both firms and consumers, that can lead to challenges but also offers us many new opportunities. And as already mentioned in the introduction, we can't imagine a life without waking up to technology and all it has to offer. Everything we will ever need right at our fingertips, from the comfort of our home.

Let us close with a quote from Jeff Bezos (founder of Amazon) that illustrates the importance of technology for consumer behaviour: "The three most important things in retail are location, location, location. The three most important things for our consumer business are technology, technology, technology."

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