Point of no return: Turning data into value

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Abstract The Cambridge Dictionary defines the point of no return as the stage at which it is no longer possible to stop what you are doing, and when its effects cannot now be avoided or prevented. Exponential advances in technology have led to a global race for dominance in politically, militarily and economically strategic technologies such as 5G, artificial intelligence (AI) and digital platforms. A reversal of this status quo is hardly conceivable. Based on this assumption, this paper looks to the future, adding the lessons of recent years — the years when the point of no return was passed. In addition, the paper uses practical examples from different industries to show how digital transformation can be successfully undergone and provides six key questions that every company should ask itself in the digital age.

KEYWORDS: business model innovation, business process re-engineering, data analytics, artificial intelligence (AI), platform economy, use case, digital transformation

INTRODUCTION: TURNING DATA INTO VALUE

Digitalisation, customisation and platformisation are just three megatrends that companies are facing in the context of digital transformation. Added to these are the challenges posed by global trade conflicts, decarbonisation and, most recently, the unprecedented COVID-19 pandemic. Nevertheless, the empirical results underlying this paper show that the vision of the Fourth Industrial Revolution (Industry 4.0) and the paradigm shift it triggered are still valid in the economy. Physical objects such as buildings or machine tools are becoming digitally connectable and networked via the Internet. The real and virtual worlds are merging, an Internet of Things (IoT), data and services is emerging in all areas of work and life. Learning and autonomous systems driven by artificial intelligence (AI) can act dynamically and independently in operation — in mobility, in the financial industry or on the shop floor. Products, services, engineering and production processes and entire infrastructures will be globally networked via platforms in the future.

A central realisation is that this will not only change organisational processes, production systems and value creation processes, but will also put the business model to the test. For many companies, this is still based on the sale of excellent products and product-related services. The examples of the mobility providers Tesla and Waymo and the consumer platforms Alibaba, Amazon and Google, on the other hand, show that the importance and market success of 'data-driven companies' and digital business models have increased dramatically in the last two decades.[1,2,3,4] One need only look at the exponential growth in the technology stocks of US and Chinese platform companies. Data-driven solution providers have connected their intelligent products and services to the Internet, are constantly acquiring product, process and user data via the corresponding sensor technology, are evaluating it and using it for product and process optimisation and the addition of digital services for the customer. At the same time, the speed with which business models must change is still underestimated in many places.[5] Industrial and service companies should adapt even more to the changes induced by new market participants to secure future business success, remain competitive and avoid lock-in effects in favour of platform companies. This is also true for the financial services industry, which has undergone a rapid learning curve in recent years. While small and agile tech and AI companies from the FinTech and InsureTech scene went on the attack, the industry giants struggled to adapt their highly regulated set-up to the changing realities.[6]

The body of studies on aspects of the digital transformation in different application areas and industries is extensive,[7–9] but there is still a lack of concrete, empirically supported implementation examples in the area of data and service-oriented value creation that companies can use as a guide to manage the transformation.[10] After all, model learning and learning from the best (or at least kindred spirits) are usually promising, as they reduce uncertainty and complexity.

The aim of this paper is to enrich the research and practice-related debate on digital business model innovations with concrete practical examples from different domains. The chosen focus is on data-based business models optimised with AI.

BUSINESS MODEL INNOVATION IN THE DIGITAL AGE: A BRIEF LITERATURE REVIEW

The business logic of traditional manufacturing companies typically follows the linear value chain model.[11] Companies process intermediate products in several stages into higher-value final products and sell them to consumers. They generate added value by controlling and orchestrating a sequence of activities that build on each

other. Markets that function according to this principle are therefore also called one-sided markets.

In contrast, platform markets are multi-sided markets characterised by the so-called network effect.[12–14] This means that the more participants of a certain group are on the platform, the more attractive a platform is for another group of market participants. Once a critical mass is reached, however, it forms a highly interconnected value creation system that significantly increases the opportunities for market transactions and significantly reduces transaction costs. If a company manages to successfully position itself as a platform provider and operate a platform business model, it can achieve a dominant position by acting as an intermediary between the producers and consumers of the market. For a pipeline company such as a machine builder, pharmaceutical manufacturer or automotive manufacturer, this poses a serious risk as it may lose the direct interface with its customers.[15]

Today, the classic business approach in industry is being broken down by data-driven companies and digital application platforms.[16] A digital platform is a marketplace that connects suppliers and consumers as well as all other providers via the Internet and enables value-adding interactions between them[17] (see Figure 1). This shift implies that a growing proportion of manufactured products are now smart, augmented by the collection, storage, analysis and evaluation of data (using AI methods such as machine learning [ML] and deep learning [DL]). These emerging smart products are changing the business logic of entire industries and markets by being carriers of digital platforms, enabling data-driven services and creating digital innovation ecosystems. On this basis, completely new business models can be created in the economy.

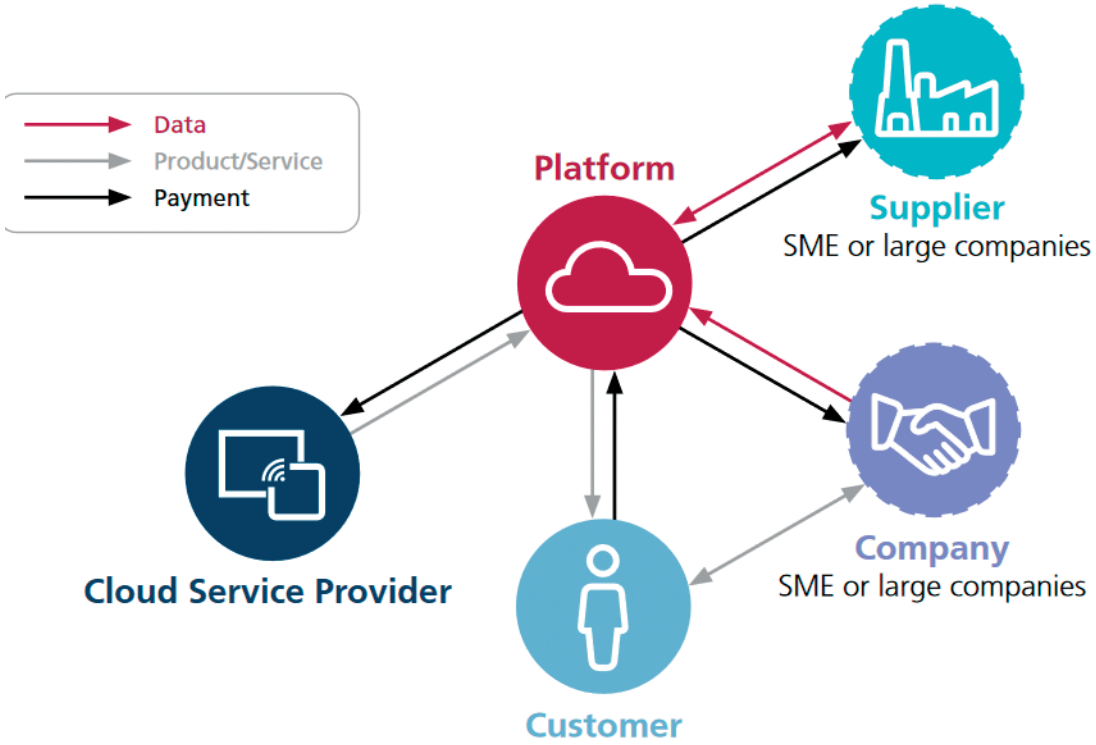

Figure 1: The platform-based ecosystem
Source: Platform Learning Systems[18]

The starting point of these new business models is the focus on the customer and their individual needs. Instead of selling a physical product such as a vehicle or a machine tool, data-driven companies aim to offer the customer an adequate range of product-service systems at any time and any place, for which the customer only pays according to actual consumption in the case of a dynamic pricing model. These flexible pricing models are already established in the insurance sector. Customers receive a guaranteed benefit and only pay for output.[19]

Another example of how these ideas are being implemented in the industry today is 'mobility-as-a-service': to get from A to B, one can use an app on the smartphone that combines different means of transport such as car sharing or public transport. The user can choose whether to take the fastest or the cheapest connection. These mobility services need data about the products, their use and about the consumers. In addition, they need data from other sources such as traffic data, movement data or weather data. They also need to be able to extract valuable information from it in real time using data analytics and machine learning.[20–22] Beyond the digitally enhanced vehicle, mobile devices play a central role in collecting this information and data on how a particular service is used.

So, if data is the commodity of the 21st century,[23] transforming it into valuable knowledge becomes a significant manufacturing process. If 'everything-as-a-service' is the preferred delivery model, highly automated cloud centres will become major global production sites. The competitive question of the future will be: Will the smart product, such as a connected, autonomous vehicle, become the platform for innovative services such as route optimisation, infotainment or automatic parking? Or will intermediaries such as fleet operators offer the user individually tailored mobility services that can also be used across transport modes?

In summary, manufacturers' business activities are traditionally focused on products and product-related services. Data-driven providers have already connected their 'smart products' to the Internet and collect and evaluate the corresponding data. Business should therefore adapt even more strongly and agilely to the changes induced by new market players to secure future business success and remain competitive.

METHODOLOGICAL APPROACH

This empirically based paper draws on primary data collected in 25 qualitative interviews with executives and experts from Germany, conducted between November 2019 and July 2020. The data was collected through explorative, semi-structured guided interviews based on existing studies, publications and projects on the relevant research and innovation areas in the manufacturing industry and the service sector.

The interviews were transcribed and evaluated using qualitative content analysis.[24] The results were produced within the framework of the project Platform Learning Systems conducted by the National German Academy of Science and Engineering (acatech) and funded by the Federal Ministry of Education and Research.

This paper consists of six main sections. After the introduction and problem definition literature review on business model innovations in the digital age and methodological approach, there follows a brief analysis of central trends in the context of the digital transformation of the economy. The subsequent section is the practice-oriented part with case studies representing data- and AI-based value networks. This section is of particular relevance because it demonstrates vividly and in real terms that digital business networks and innovation ecosystems do indeed emerge in Europe, especially in the business-to-business (to-consumer) environment, where particular

strengths of the German economy lie.[25] The final section takes up the initial question of how concrete value can be created from data and identifies six empirically supported questions that every company should ask itself in the digital age.

THE DIGITAL TRANSFORMATION OF THE ECONOMY

In the following, key findings from the 25 qualitative interviews with managers, experts from various industries and disciplines are summarised in the form of qualitatively derived statements. These synthesised statements, referred to as trends in the digital transformation, shed light on different aspects of the transformation process on which companies should place a special focus in 'change management'.

Trend #1: Data drives business transformation

The interview results consistently support the thesis that data is increasingly becoming economic goods, has value and is the basis of innovative and digital business models. Once they have left the factory, smart products such as machine tools, vehicles, medical devices or entire buildings continue to be connected via the Internet and exchange huge amounts of data during their use.[26] This big data is refined into smart data, which can then be used to control, maintain, or extend and improve smart products and services.[27] Data enables new knowledge that forms the basis for expanded or new business models.

Data aggregation, breaking down data silos, consolidation and refinement by means of real-time analysis and AI is increasingly taking place via digital platforms, which can become the dominant marketplace.[28] The majority of the companies surveyed from the automotive industry, mechanical and plant engineering, process industry, medical technology, agriculture and logistics already have products and product-related services that are equipped with their own Internet protocol (IP) address, microchip or sensor and connected to the Internet. They collect data, evaluate it throughout the product life cycle and use it to enable a better user experience (UX), for example. Platforms are the digital infrastructure for this, for example to combine device management with simple connectivity, data storage systems and an app store. The app store offers individually configurable services provided by an open digital ecosystem. The quality of the digital innovation ecosystem and how quickly it can be built will be crucial for the successful implementation of new data-driven business models. This requires solving different challenges in terms of funding, performance, reliability and data security, intellectual property protection and standardisation.

Trend #2: Digital business models complement outdated product offerings

Following the principle of the circular economy, digital sharing platforms, for example, can contribute to greater efficiency and sustainability along the entire product life cycle by increasing the utilisation of machinery, equipment, vehicles and housing. Consumer platforms such as Uber, Airbnb and Amazon have shown that they have a lasting impact on or threaten established business models from transport and accommodation to stationary retail.[29] One characteristic of digital platforms is the network and scale effects that arise. The more players are connected via the platform, the more the participants in the platform ecosystem benefit from its use and the more attractive the platform becomes for new customers, developers and providers.[30,31] The rapid and sustained growth of platforms is a crucial factor in their market success and their propensity to dominate markets.

In recent years, US and Chinese companies such as Amazon and Alibaba, Google and Baidu and Facebook and Tencent, whose business models are based on digital platforms, have achieved

enormous success in the business-to-consumer (B2C) sector. These types of platforms are now also emerging in the business-to-business (B2B) sector. With these platforms, the principle of 'the winner takes all' is not equally set, which is due to the importance of complexity of the value creation processes and domain knowledge. In addition to the advantages mentioned, platform markets also have structural weaknesses, eg concentration tendencies towards monopolisation. Google, for example, has a 95 per cent market share in search engines in Europe. Amazon also influences the offer and prices in e-commerce. In this way, competition law is also facing new challenges.

Trend #3: Co-evolution and collaboration in business

The empirical results indicate that no company alone has the necessary know-how to be permanently successful in the digital age. Through co-evolution and collaboration, companies can jointly offer complementary solutions to their customers and increase their competitiveness.[32,33] When several innovators successfully cooperate in the environment of a platform, innovation ecosystems emerge. In the future, according to the expectations of individual interview partners, competition will develop more between digital innovation ecosystems than between individual companies, because they offer more complete solutions than traditional providers. Here are opportunities for start-ups and small to medium enterprises (SMEs) to bring their innovative, highly specialised offerings and competences into these ecosystems without having to take a higher entrepreneurial risk by building their own platforms.

The technical possibilities of sensor technology and connectivity (5G, 6G), edge and cloud infrastructures, data analysis and AI, data platforms and advances in autonomy and collaborative robotics are inspiring companies in industry and the service sector to make their core processes more efficient and to manufacture products and services digitally. This development will take a rather evolutionary course. Data-driven business models, platform markets and digital ecosystems, on the other hand, have a disruptive effect.[34,35] Current business models can be cannibalised within very short time spans, regardless of the industry. This new view of business is still underrepresented in many 'traditional' companies.[36] Established business models and previously successful companies are being attacked by start-ups, but also by companies and platforms from outside the sector, and their continued existence is being called into question.

Trend #4: From optimised production to data-driven business model innovations

The boundaries between manufacturing, service companies and the IT and Internet industry are becoming increasingly blurred, as the expert assessments show. In addition to industrial upgrades,[37] manufacturers and suppliers need new competences in the areas of cyber and IT security, data science and data analysis with AI methods. Even though many companies have already initiated digitisation projects, and some can also present a digitisation strategy including an implementation roadmap, it is often underestimated how quickly and radically business models must change in order to ensure sustainable market success in the digital age. The ideal-typical digitisation path in a company ranges from networked and optimised production to the conversion or expansion of the business model (sales, licensing models, as-a-service offerings), to innovating in digital ecosystems (see Figure 2). Each stage has different challenges, for example around vertical and horizontal integration, IoT capabilities and standardisation and interoperability.

	Connect & operate live	Optimise & supply efficiently	Expand & boost sales	Innovate & develop ecosystem
Business model	**Products & support services**	**Product services & after-sales services**	**Product-as-a-service & value-added service**	**Data-driven digital business model**
Business driver	Product sales	Process optimisation	Service growth	Expanded ecosystems
IoT capacities	Embedded systems, augmented reality	Analytics, machine learning, optimisation	Service management (portfolio, product management)	Ecosystem business development
Integration & technology	Vertical integration (OT-IT), machine connectivity	Horizontal integration (planning to delivery)	Services platform, SLA management	Open data platforms, business networks
Standards	Connectivity (e.g. OPC-UA)	Semantic standards	Service interoperability	Cross-sectoral standards
	Optimised production		**Smart services**	**Innovation business**

Figure 2: From optimised production to data-driven business model innovations
Source: Kagermann and Winter[38]

Trend #5: From manufacturer to product service provider

Individualised product-service systems that are tailored to users and offered via platforms and digital marketplaces can hardly be developed and operated by a single company due to their complexity. It is therefore important to create these product-service systems collaboratively, which requires an overarching, automated exchange of data between different actors. To achieve collaboration, traditional rigid value chains must be broken up and dynamic value networks established. In this way, data can be shared and used pre-competitively and the basis for the development of data-based product-service systems can be laid.

Autonomous vehicles are an example of complex product-service systems that are created in value creation networks. While the best communication networks today have latency times of 10 to 15 milliseconds, the upcoming 5G mobile communications standard will offer mobile Internet availability almost in real time. Data latency — the time that elapses between data retrieval and data provision — will be reduced to just 1 millisecond in the future. 5G is fast, instantaneous, energy efficient and reliable — a fundamental requirement for the next generation of digitally enhanced products and services. The interviews showed that there is still a trend towards autonomous systems in the industry, even though the COVID-19 crisis has led to greater cost discipline and new strategic thinking in the automotive industry, for example. Thanks to the enormous advances in AI, it is now possible to extract valuable information and insights in real time from data collected via sensors.[39] This data also serves as training material for self-learning and autonomous systems that recognise the structure of their environment themselves and generate their own knowledge base that can be continuously updated during operation.[40] Examples include self-driving public transport shuttles or autonomous vehicles in logistics that can independently take on more complex tasks in public and industrial environments.

BEST PRACTICES: DATA- AND AI-BASED ECOSYSTEMS

Many companies are facing the challenge of innovating their business model and aligning it with the changed competition triggered by various megatrends. Best practice cases have proven to be a crucial orientation aid

for shaping the digital transformation. This is because model learning and learning from the best (or at least kindred spirits who have already set out) is possible on the basis of empirically supported implementation examples that stand for data- and service-oriented value creation and take into account the learning experiences and success factors of other entrepreneurs. There are no guarantees of success, because the transformation path taken may need to be adjusted in a few years; the future challenges mentioned are too unpredictable. But exemplary use cases provide guidance and the urgently needed concretisation in the digitalisation debate: in retrospect, what was successful, what was not, and what companies should pay special attention to in managing change.

The following best practice cases show that the use of digital infrastructures as well as tools and methods for data collection and evaluation allows companies in all sectors to expand their product and service offerings and better adapt them to customer needs. To achieve this, it is important to network different actors in the value network to enable continuous access and utilisation of data across silos and company boundaries.

In contrast to dedicated stand-alone solutions for a specific field of application, some companies rely on special development departments that question existing solution processes in a kind of technology transformation and set themselves the task of investigating where the use of AI technologies can make a meaningful contribution. For example, Prosegur, one of the global market leaders in the security and value industry, created the so-called GENZAI Platform in its AI Tech Studio in 2020. On this basis, the company tackles all AI-related topics centrally. Through its diverse network of surveillance cameras, detectors of all kinds and the growing number of IoT devices, the security industry already has the relevant amounts of data to create new and highly effective security systems with video and audio pattern algorithms. These systems will not only be able to detect threats more accurately, but also significantly reduce high false alarm costs. During the pandemic, it was then possible to use the infrastructure created to develop an application at short notice that assures employees of a COVID-free working environment. This is ensured by a combination of data and its analysis, such as mask wearing and temperature detection or social distancing and contact tracing. A simple feedback of the analysis in the form of a traffic light system to the employee creates practicability and the feedback to the access control systems in the company creates the necessary security.

Best practice: Resilient production lines through AI

In the highly automated manufacturing industry, unplanned machine and plant downtimes generate cost-intensive production losses. Using machine-integrated sensors and AI-based evaluation, the machine and plant function can be permanently monitored. Anomalies such as higher energy consumption or below-average performance are detected, allowing machines and plants to be checked and maintained at an early stage without causing a breakdown (smart maintenance). This data-based process optimisation and digital refinement of the production line increases productivity while reducing the number of downtimes and production stops. The IoT solution provider Relayr has added an additional value proposition to this data-based innovation (guaranteed availability) by having a financing and insurance partner minimise the risk of production downtime that nevertheless occurs via digital downtime insurance (see Figure 3).

The solution is already in use in the automotive industry. The current hurdles are that in many industries the necessary data security for monitoring by means

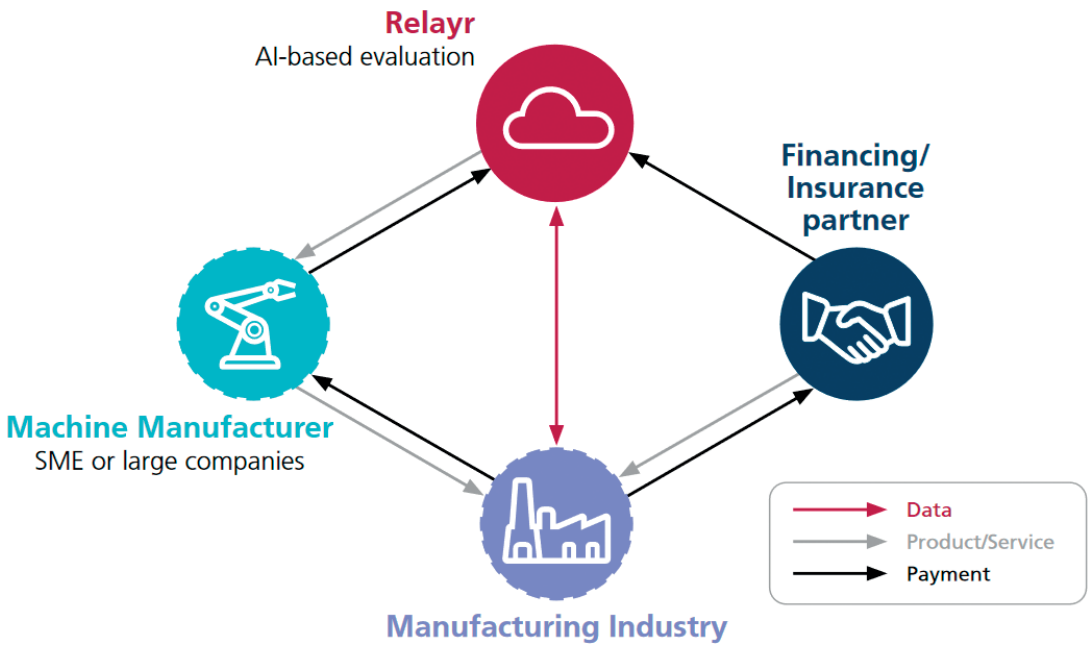

Figure 3: The resilient production line
Source: Platform Learning Systems[41]

of smart maintenance are problematic. A corresponding digital infrastructure is also required to store and process the large amounts of data generated by the measurements of relevant machine functions. AI-based evaluation at the edge (directly at the machine) and decentralised evaluation of the machine functions can significantly limit the amount of data to be processed.

Best practice: AI-supported anamnesis

In a European comparison, doctor–patient contacts are particularly frequent in Germany. There is potential for efficiency here if many visits to the doctor can be avoided or better directed to the right place in the medical care system by clarifying the symptoms of the illness or the reason for the visit in advance. The Berlin start-up Ada Health has developed an AI-based solution for anamnesis so that users can ask simple questions for a preliminary diagnosis via an app (see Figure 4).

This AI-driven solution based on a probabilistic system for patients, co-developed by doctors, offers clear advantages over a classic search engine, as personalisation is possible and defined exclusion criteria as well as the latest clinical studies and research results can be taken into account. A white-box model makes the AI decision making more comprehensible, enabling a critical evaluation of the results. So far, 10m users have had 20m symptom analyses generated. The application is present in several health systems worldwide and is certified according to ISO 27001 (Certified Information Security Management System), CE (Medical Device Risk Class 1) and BiM (Quality Product Internet Medicine from the German Association of Internet Medicine), among others. Implementation hurdles are due, among other things, to inconsistent legal frameworks and different interpretations of the General Data Protection Regulation (GDPR). Nevertheless, this digital business model shows how efficiency and innovation effects can arise in regulated markets through digital innovations and can complement physical products and services.

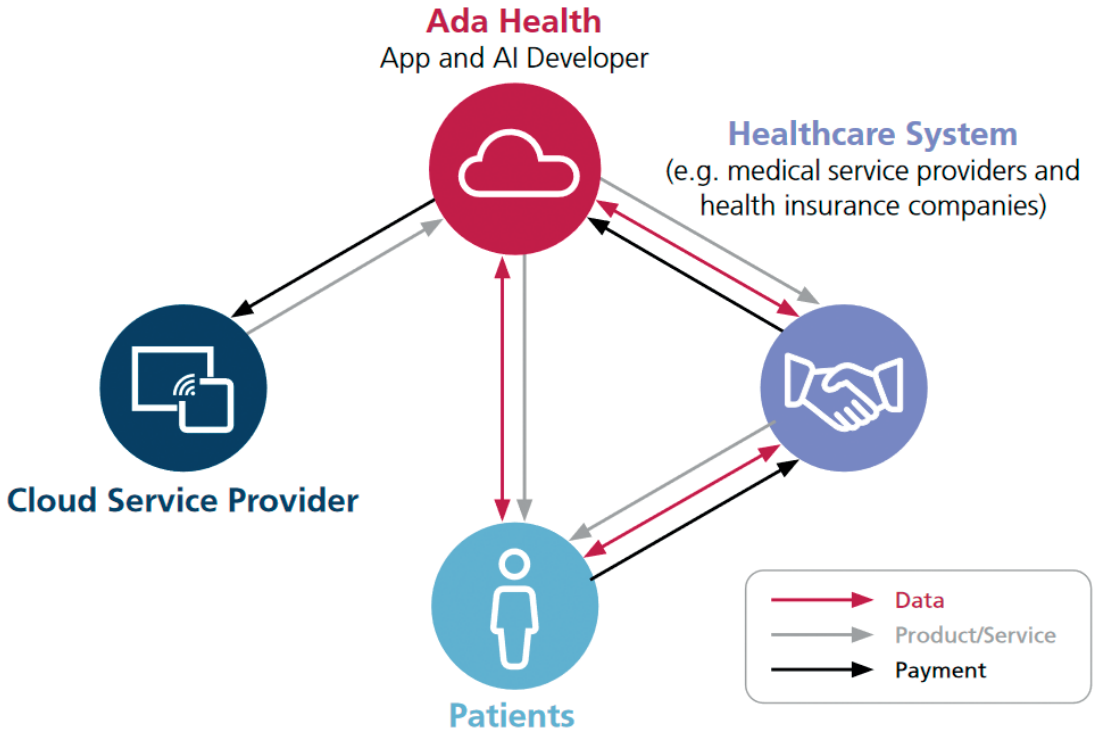

Figure 4: AI-driven anamnesis
Source: Platform Learning Systems[42]

Best practice: AI-based forecasting in logistics

The forward-looking planning of the required inventories and storage capacities is a challenge in logistics. After all, several influencing factors such as customer demand, sales planning or the resilience of supply chains must be considered. The start-up Westphalia DataLab has developed an AI-based forecasting solution with the logistics company (see Figure 5).

The model learns based on existing company data and other internal and external influencing factors (weather, market development, etc.) and enables future sales figures to be calculated. This makes it possible to plan the company's business development more accurately. The logistics customer uses a software-as-a-service offer, ie the software as well as the cloud and data infrastructure are operated by the software provider and used by the logistics company as a service according to demand. In addition to using historical sales data, it is also possible to utilise data from the Internet (via so-called crawlers, ie computer programmes that automatically search web documents) or to purchase data.

After the data has been provided, it is automatically analysed. In the process, various models are calculated using ML methods. Ultimately, the forecast model that has the highest accuracy and offers a high customer benefit is applied. In this case, the logistics company is an innovation driver as well as an investor and customer of the forecasting solution. One obstacle to innovation is that the lack of standards and quality deficiencies in master and mobility data can lead to higher costs for data cleansing. Poor data quality would lead to incorrect forecasts. Companies are also not always open to sharing data such as sales and forecast data from different value chains in a pre-competitive manner. On the other hand, there is immense potential for digital business model innovation, which usually

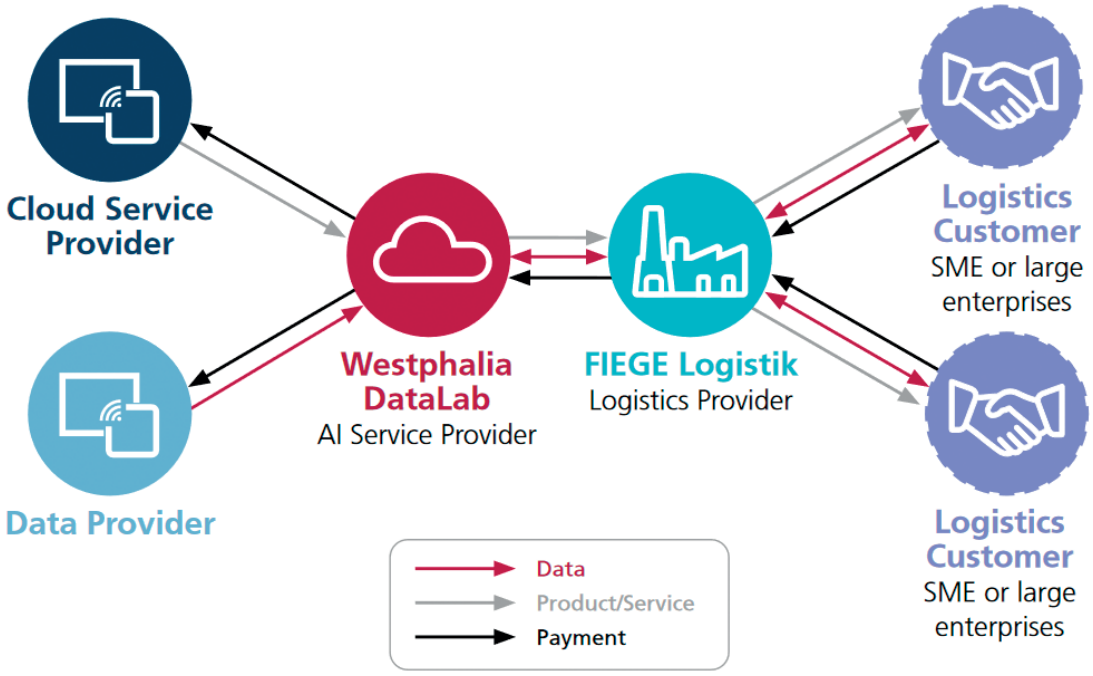

Figure 5: AI-based forecasting
Source: Platform Learning Systems[43]

requires a collaborative approach to value creation.

Towards a trustworthy AI

In summary, it can be stated that an important success factor of a data-based value network is that all participants can define a clear benefit and a clear value proposition, which they could not realise alone. Data and AI-based approaches are important drivers of business model innovation in the digital age; however, many companies lack knowledge and skills in dealing with data science and AI methods. To close this gap, relevant research and industry partners can be integrated via the value network, both as a complementary link between provider and customer or via a bilateral interface to the buyer of digital expertise and solutions. Longer-term cooperations enable a sustainable build-up of competence at the demand side. Through an agile roll-out, the first results of collaborative value creation can be brought to market at an early stage and further developed with customers and partners to serve customer preferences in the best possible way.

Nevertheless, the use of new technologies always leads to questions of ethics. Of course, AI programmes cannot be used exclusively for constructive purposes; like all technical instruments, they also harbour risks of misuse. For example, a truck can be used today to bring relief supplies that are essential for survival to a disaster area, and it can be misused by assassins to carry out a terrorist attack on innocent passers-by. Gottlieb Daimler certainly did not have the latter in mind when he had the first truck, which at the time had 4 horsepower, delivered to the British Motor Syndicate in London on 1st October, 1896.

When Mark Zuckerberg founded Facebook's predecessor in 2003 while at Harvard, he probably did not think that just a decade later, targeted social media campaigns from abroad would be influencing the elections of US or British citizens. Facebook's increasing importance as a news channel was documented in 2015 by the

Reuters Institute at Oxford University. According to this, 23 per cent of 1,969 respondents across Germany of all age groups got their news from Facebook. And of course, the dangers posed by new technical possibilities must be identified, assessed and prevented.

Mark Zuckerberg repeatedly pointed out at his hearing in the US Senate in spring 2018 that it is imperative to have 'AI tools' to filter the vast amounts of data in order to effectively weed out so-called 'fake' content and content with an illegal background. The discussions also led, however, to the fact that an increasing public vigilance can be observed. In this context, it is remarkable how the public built up pressure on US corporations.[44]

Microsoft, for example, is cooperating with the Department of Homeland Security on data storage. The cloud service Azure uses AI to determine the identity of people in real time. The introduction of a decree to separate children of illegal immigrants from their parents shocked large parts of the US population. As a result, criticism was also directed against Microsoft. This led to the company's CEO Satya Nadella, himself the son of Indian immigrants, speaking out: 'We at Microsoft are shocked by the forcible separation of children from their families at the border crossing', he declared and demanded that Congress pass appropriate laws against the practice.

At Google, public pressure led to concrete consequences. The company withdrew from 'Project Maven' with the Department of Defence — under pressure from employees. The programme helps the Pentagon to better recognise people, vehicles, buildings or weapons caches in drone videos with the help of AI. Some employees had indignantly left the company, while thousands had signed a petition saying that Google had no place in the 'business of war'.

It is understandable that a single company has this option. States, however, especially in their national security and defence policy, can hardly afford a strategic disadvantage by not using AI. According to reports in the *New York Times* on 26th August, 2018, Secretary of Defence James Mattis is trying to find a dialogue with experts from Silicon Valley. For this purpose, the Joint Artificial Intelligence Center (JAIC) was established in June 2018, which is to receive US$75bn US from the defence budget over the next five years and where, among other things, the above-mentioned Project Maven will be further developed.

Without the willingness to share data, digital value networks cannot develop productively. Therefore, trust and agreements between all partners are needed. Furthermore, guaranteed data security is important, for example by carrying out data analysis 'on edge', ie decentral at the machine, and only storing generic functionalities in the cloud. From a German point of view, the infrastructure and technology providers should also be in Germany and Europe to enable trust and data sovereignty. Possible backdoors, such as the release of data under the 'US Cloud Act' (Clarifying Lawful Overseas Use of Data Act), should be considered when choosing a provider. The use of white-box models can also mitigate the challenge of traceability of AI-based results. So, solutions are available; what is still missing is widespread implementation.

OUTLOOK: HOW DATA CAN BE TURNED INTO VALUE

European companies have not been nearly as successful in the platform economy as their competitors from the US, China or Korea. Although this has so far mainly been the case for consumer platforms and services such as Alibaba, Amazon, Facebook, Google and TikTok, it is a wake-up call for the local economy to expand products and services with digital, scalable services in order to continue to satisfy customer needs in the future. More than that, they need to become

digital champions to lead the way in a connected, data-driven global economy. The stronger entry of European companies into the platform economy is therefore important, as software platforms generate scale and network effects and are often disruptive due to their enormous reach.[45,46] The more users a platform has, the larger it becomes, the more difficult it is for competitors to attract their own users to their platform. By inserting themselves between traditional providers of products and services and their customers, platforms threaten to lose the customer interface and with it access to user-related data, which is increasingly gaining economic value in a world of batch size 1 at the price of a mass product. As a result, value creation threatens to shift in favour of platform providers, and traditional providers of products and services are degraded to suppliers of the platform provider.

AI is a key technology of the 21st century and, in combination with data, it is the basis for expanded or new business models that can be scaled via platforms. Companies should develop a clear data strategy for this, which defines the quality, relevance and availability of the data required for value creation. In addition, the development of strategic know-how partnerships with corporates, SMEs, start-ups and research institutions as well as the agile reflection and adaptation of the business model must be continuously pursued to meet the dynamic requirements of the market. At the same time, the focus is on framework conditions and regulatory issues, for example in the areas of technical interoperability of data and platforms, the establishment of reference architectures and open standards, as well as competition law and the unified digital single market.

Six questions derive from the empirics that every company should ask itself in the digital age:

1. How can the existing business model be expanded to include digital services?;
2. How can products, services and product-service packages be connected to the Internet, made available via platforms and accompanied throughout the entire product life cycle?;
3. Does the analysis of real-time usage data of products and services bring new knowledge that can be exploited or marketed?;
4. Can products also be offered as an 'as-a-service' business model in an economic way?;
5. How can elements of the value chain be partially or fully digitised? And would this digitalisation change the control points in favour of the own company?;
6. What strategic partnerships via collaborative value creation approaches might make sense, for example to offer convincing market services that could not be offered alone?

The paper shows that there are convincing examples of data monetisation and cooperation in value creation networks and that these offer reason to continuously innovate one's own business model. This is a banal-sounding but important finding, as the qualitative survey suggests that the Industry 4.0 wake-up call has arrived across the board, but many manufacturers' business activities are still focused on products and product-related services. There is apparently a lack of implementation for a wide variety of reasons. The six questions can productively support the path towards implementation, as the examples have shown for AI-based data monetisation and collaborative innovation in value networks. The path has been described; what is still missing is decisive implementation — so-called business and digital transformation.

References

1. McAfee, A. and Brynjolfsson, E. (2017), *Machine, Platform, Crowd: Harnessing Our Digital Future*, W. W. Norton & Co., New York.
2. Parker, G. G., Van Alstyne, M. W. and Choudary,

S. P. (2016), *Platform Revolution: How Networked Markets Are Transforming the Economy*, W. W. Norton & Co., New York.
3. Accenture (2020), 'Five ways to win with digital platforms', available at https://www.accenture.com/us-en/_acnmedia/pdf-29/accenture-five-ways-to-win-with-digital-platforms-full-report.pdf (accessed 7th September, 2020).
4. Winter, J. (2021), 'Digital Business Model Innovation: Empirical insights into the drivers and the value of Artificial Intelligence', *International Journal of Computers and Technology*, Vol. 21, pp. 63–75.
5. Kagermann, H. and Winter, J. (2018), 'The second wave of digitalisation Germany's Chance', in Mair, S., Messner, D. and Meyer, L. (eds.), *Germany and the World 2030. What Will Change. How We Must Act*, Econ, Berlin.
6. Werne, J. (2020), 'Artificial Intelligence meets Homo Sapiens', in Stadelmann M., Pufahl M. and Laux D. (eds), *CRM Goes Digital*, *Edition Sales Excellence*, Springer Gabler, Wiesbaden, pp. 81–92.
7. Schallmo, D., Williams, C. A. and Boardman, L. (2017), 'Digital Transformation of Business Models – Best Practice, Enablers, and Roadmap', *International Journal of Innovation Management*, Vol. 21, No. 8, pp. 1–17.
8. Matt, C., Hess, T. and Benlian, A. (2015), 'Digital Transformation Strategies', *Business & Information Systems Engineering*, Vol. 57, pp. 339–343.
9. Westerman, G., Bonnet, D. and McAfee, A. (2014), 'The nine elements of digital transformation', *MIT Sloan Management Review*, Vol. 55, No. 3, pp. 1–6.
10. Platform Learning Systems/acatech (2020), 'From Data to Value Creation. Potentials of data- and AI-based value networks', Munich.
11. Porter, M. E. and Heppelmann, J. E. (October 2015), 'How smart, connected products are transforming companies', Harvard Business Review, available at https://hbr.org/2015/10/how-smart-connected-products-are-transforming-companies (accessed 7th September, 2020).
12. Rochet, J-C. and Tirole, J. (2016), 'Two-sided markets: A progress report', *RAND Journal of Economics*, Vol. 37, No. 3.
13. Tiwana, A. (2013), *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*, Morgan Kaufmann, Waltham, MA.
14. Rysman, M. (2009), 'The Economics of Two-Sided Markets', *Journal of Economic Perspectives*, Vol. 23, No. 3, pp. 125–143.
15. Cusumano, M., Gawer, A. and Yoffie, D. B. (2019), *The Business of Platforms: Strategy in the Age of Digital Competition, Innovation, and Power*, Harper Collins, New York.
16. Kagermann, H. and Winter, J. (2017), 'Industrie 4.0 und plattformbasierte Geschäftsmodellinnovationen', in Lucks, K. (ed.), *Praxishandbuch Industrie 4.0*, Schäffer Poeschel, Stuttgart, pp. 21–32.
17. *Ibid.*, ref. 2.
18. *Ibid.*, ref. 10.
19. *Ibid.*, ref. 5.
20. Muro, M., Maxim, R. and Whiton, J. (2019), 'Automation and Artificial Intelligence: How machines are affecting people and places', Brookings, available at https://www.brookings.edu/research/automation-and-artificial-intel-ligence-how-machines-affect-people-and-places/ (accessed 7th September, 2020).
21. Winter, J. (2020), 'The evolutionary and disruptive potential of Industrie 4.0', *Hungarian Geographical Bulletin*, Vol. 69, No. 2, pp. 83–97.
22. *Ibid.*, ref. 2.
23. Mundie, C. (2014), 'Privacy Pragmatism: Focus on data use, not data collection', *Foreign Affairs*, Vol. 93, p. 28.
24. Glaeser, J. and Laudel, G. (2004), *Expert Interviews and Qualitative Content Analysis*, VS Publishers, Wiesbaden.
25. Winter, J. (2017), 'Europe and the Platform Economy – How Data-Driven Business Models are Changing Value Chains (Europa und die Plattformökonomie)', in Bruhn, M. and Hadwich, K. (eds), *Dienstleistungen 4.0*, Springer Gabler, Wiesbaden, pp. 71–88.
26. Tolio, T., Copani, G. and Terkaj, W. (2019), *Factories of the Future. The Italian Flagship Initiative*, Springer, Heidelberg.
27. Xu, L. D. and Duan, L. (2019), 'Big data for cyber physical systems in Industry 4.0: A survey', *Enterprise Information Systems*, Vol. 13, No. 2, pp. 148–169.
28. Wahlster, W. (2017), 'Artificial intelligence as the basis of autonomous systems', *Informatik-Spektrum*, Vol. 40, No. 5, pp. 409–418.
29. *Ibid.*, ref. 4, p. 63.
30. *Ibid.*, ref. 15.
31. Evans, P. C. and Gawer, A. (2016), *The Rise of the Platform Enterprise. A Global Survey*, 1st edn, The Center for Global Enterprise, New York.
32. Daugherty, P. and Wilson, P. H. J. (2018), *Human + Machine: Reimagining Work in the Age of AI*, Harvard Business Review, Cambridge, MA.
33. Moore, J. F. (May–June 1993), 'Predators and prey: A new ecology of competition', *Harvard Business Review*, Vol. 71, No. 3, pp. 75–86.
34. Christensen, C. M., Raynor, M. E. and McDonald, R. (December 2015), 'What Is Disruptive Innovation?', *Harvard Business Review*, Vol. 12, Special Feature.
35. *Ibid.*, ref. 11.
36. Cooper, R. G. and Friis Sommer, A. (2020), 'New-Product Portfolio Management with Agile Challenges and Solutions for Manufacturers Using Agile Development Methods', *Research Technology Management*, Vol. 63, No. 1, pp. 29–38.
37. Winter, J. (2010), 'Upgrading on TNC subsidiaries', *International Journal of Automotive Technology and Management*, Vol. 10, Nos. 2–3, pp. 145–160.
38. *Ibid.*, ref. 5.
39. Stone, P., Brooks, R., Brynjolfsson, E., Calo, R., Etzioni, O., Hager, G., Hirschberg, J., Kalyanakrishnan, S., Ece, K., Kraus, S., Leyton-Brown, K., Parkes, D., Press, W., Saxcenian, A., Shah, J., Tambe, M. and Teller, A. (2016), 'Artificial

Intelligence and Life in 203', One Hundred Year Study on Artificial Intelligence: Report of the 2015–2016 Study Panel, Stanford University, Stanford, CA.
40. Nicholson, J., Gimmon, E. and Felzensztein, C. (2017), 'Economic Geography and Business Networks: Creating a Dialogue between Disciplines: An Introduction to the Special Issue', *Industrial Marketing Management*, Vol. 61, pp. 4–9.
41. *Ibid*., ref. 10.
42. *Ibid*., ref. 10.
43. *Ibid*., ref. 10.
44. *Ibid.,* ref. 6.
45. *Ibid.,* ref. 25.
46. Winter, J. (2020), 'Service innovations in the digital age – What slows them down, what to do' ['Dienstleistungsinnovationen im digitalen Zeitalter – Was sie bremst, was zu tun ist'], in Bruhn, M., Hadwich, K. (eds), *Automation and Personalisation of Services. Forum Service Management*, Springer Gabler, Wiesbaden, pp. 105–118.