



Digital Transformation

▶ Digital Machinery Decoded

A practical guide for machinery companies to navigate digital transformation and outperform competition

Table of content

1	Preface	03
2	Status quo of machinery industries	06
3	Industrial IoT	09
3.1	Industry 4.0 implementation – from pilots to impact at scale	09
3.2	Mastering digital operational excellence with digital thread and digital twin	11
3.3	Boosting quality management through machine learning	14
3.4	The data-driven service opportunity	16
4	Next generation of B2B commerce	20
4.1	The digital customer platform of the future	20
4.2	The path towards an integrated B2B commerce platform	23
4.3	B2B commerce roadblocks	24
5	Structuring digital transformation for digital machinery	26
5.1	Set the direction	26
5.2	Design the change	30
5.3	Execute the transformation	33

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1 Preface

The European machinery industry has experienced impressive growth over the last decade. The vast majority of European machinery companies are valued globally, as their products meet the highest individual customer demands in terms of innovativeness, functionality, quality, and reliability. And the European machinery industry has also been able to strengthen its market position despite globalization trends in general and competition from Chinese rivals in particular. But this success is not set in stone. Machinery companies are currently affected and challenged by three concurrent, technology-driven shifts:

- ▶ **New foundation of digital technologies** – posing questions regarding value creation, product and service innovation, and required capabilities – from delivering spare parts to leveraging 3-D printing, from human experts to self-learning systems
- ▶ **Revolution of buyer markets** – posing questions regarding business models, customer relationships, and product life cycles – from supplier to productivity partner, from combustion to electric engine, from hardware to software and digital services
- ▶ **Increasing pace of digitalization** – posing questions regarding ecosystem positioning, digital excellence, and data monetization – from machine automation to connectivity and analytics, from single machines to entire value networks

These shifts carry the risk of weakening the solid position of incumbent machinery industry players. In an increasingly software-driven environment, machinery companies cannot rely on their hardware strengths alone, not even with advanced embedded software. The upcoming cyber-physical world (Internet of Things) requires competency in both fields – the Internet AND Things.

On the other hand, machinery companies can also turn these shifts into new opportunities for further growth, greater efficiency, and increased customer satisfaction. This publication serves as a guide for machinery companies to successively seize the opportunities arising from the aforementioned market shifts.

While the need for increased digital transformation efforts to secure competitive advantages has arrived at machinery's top management level, the exploitation of correlated gains lags behind expectations. The reasons may be diverse and company-specific but, in most cases, are based on seven fundamental shortcomings that leading machinery companies need to overcome:

1. Efficiency-focused, short-term digital initiatives vs. leveraging digitalization to innovate products/services and build integrated customer experiences
2. Underutilization of B2B commerce as just another sales channel vs. combining the Industrial IoT and e-commerce into a customer-centric approach that unlocks new powerful types of customer interactions
3. Reliance on strong hardware knowledge (with embedded software) vs. developing and integrating new hybrid and purely digital capabilities into existing operations
4. Position as single industry player with best-in-class solutions vs. new (digital) ecosystem player collaborating, co-operating, and co-innovating with partners and peers
5. Reliable, quality-focused developer of complete products vs. joint prototyping with customers and/or partners on new digital innovations to overcome challenges of size and scale
6. Legacy organizational structures for digital initiatives vs. new digital operating models that empower teams, foster collaboration, and create a test-and-learn culture
7. Narrow innovation focused on improving/enhancing existing solutions (10 percent thinking) vs. using customer pain points to radically rethink existing solutions (10 times thinking)

Strategic areas of action for machinery companies

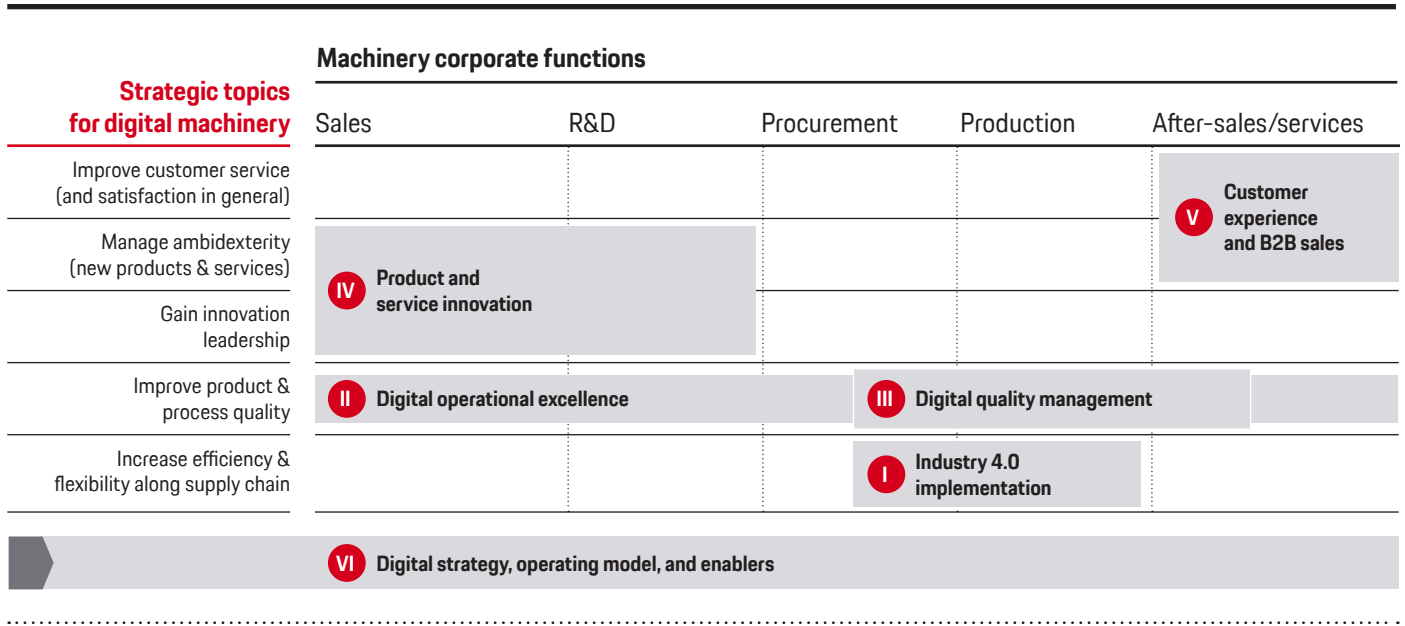


Figure 1

This publication provides proven approaches on how to resolve the shortcomings that often threaten successful digital transformation in industry. Drawing on prior Porsche Consulting transformation projects with various industrial goods companies and a recently conducted survey among 50 executives of leading machinery companies, this paper focuses on six areas of action for any hardware-driven incumbent company to evolve into an integrated hardware, software, and digital service player. Figure 1 illustrates these action fields in a matrix of the most relevant strategic digital machinery topics (y-axis; confirmed by interviewed managers, see chapter 2), and the functional areas they impact the most (x-axis).

I Industry 4.0 implementation

Our recent survey also confirmed that a large number of machinery companies have begun their first Industry 4.0 use case initiatives, mainly with the associated goal of increasing efficiency and flexibility along supply chains. Most of these initiatives are stuck in the pilot phase, however, while rollouts are still limited. The question is why?

Chapter 3.1 highlights the top fifteen efficiency use cases currently piloted in production and supply chain environments and describes the most common deployment pitfalls to avoid.

II Digital operational excellence

One of the key strategic topics of our clients and the machinery executives interviewed is the improvement of product and process quality. In the past, machinery companies have

been devoted to operational excellence, focusing on optimizing their physical assets, but recent trends now necessitate digital excellence. The key to digital excellence is an end-to-end digital information flow along the entire product life cycle, known as the “digital thread.” These digital thread opportunities can extend to an even higher level when machinery companies create dynamic digital models of their physical entities, enabled by the Industrial Internet of Things and advanced simulation technologies. These models are recognized as “digital twins.”

Chapter 3.2 describes how to master digital excellence with a combined digital thread and digital twin approach.

III Digital quality management

To maintain strong positioning and expand the customer base in an increasingly competitive environment, machinery companies have to meet the highest quality and reliability standards, in some customer industries with output error tolerances far below 1 percent. While traditional quality management approaches, mostly based on manual inspections, are error-prone and not scalable, new technologies enable machinery companies to optimize all relevant quality dimensions at the same time: improved quality, reduced costs, and enhanced yield.

Chapter 3.3 explains how machine-learning algorithms can boost quality management and describes the most relevant application areas.

IV Product and service innovation

Recent advances in the Industrial IoT, ubiquitous machinery connectivity, and advanced analytics pave the way for a new era of industrial services. Reduced costs in service delivery and closer client relationships are the key areas to benefit from these new, data-driven service opportunities. In addition to the service revolution, there has also been a gradual, albeit radical shift in business and pricing models from ownership based to outcome based.

Chapter 3.4 describes a practical path for the exploitation of these new digital service and business model opportunities, from both the OEM and the supplier perspectives.

V Customer experience and B2B sales

Driven by three fundamental trends (consumerization, sales automation, and servitization), the demand for digital sales channels is rising in B2B environments. Few machinery companies have started e-commerce initiatives, with many hesitating or struggling with the implementation of customer-centric digital sales operations. Scalable potential is further diminished by assuming the narrow perspective that e-commerce is merely an additional sales channel.

Chapter 4 advances into this new era of B2B client relationships and suggests a new commercial model that consolidates all relevant vendor-client information into a single platform, combining the best of the IoT and e-commerce. Furthermore, chapter 4 explains why machinery companies are struggling to become customer-centric and suggests appropriate mitigation measures to build integrated digital sales channels faster and more successfully.

VI Digital strategy, operating model, enablers

Independent of the strategic focus on digitalization, incumbent machinery companies need a clear digital agenda – an overall navigation system for a company's digital transformation, unifying strategic direction, ambition levels, enablers, and the measures to achieve them and condensed into a coherent roadmap for accelerated implementation. The second core element is a coherent digital operating model designed to serve as a blueprint for the structures, digital governance, mechanisms, competencies, and culture needed to execute the digital strategy at scale. And finally, machinery companies have to put identified digital transformation enablers, such as competencies or technologies, into action to achieve impacts at scale.

Chapter 5 of this study summarizes and outlines twelve imperatives to successfully maneuver through the digital transformation journey and master key digital machinery topics.

2 Status quo of machinery industries

This chapter summarizes the results of a survey Porsche Consulting conducted in October of 2017 among 50 machinery executives in DACH and Italy. The purpose of the survey was to assess how machinery companies are currently approaching and navigating digital transformation. It focused on strategic direction, deployment stages of the most value-adding digital use cases, and challenges to scaling and implementing digitalization. The following section lists the key findings and examines the survey's results in detail.

- ▶ **Digitalization will impact the core value of machinery companies.** Executive focus is on digital customer interactions, new data-driven profit pools, and changing competencies.
- ▶ **Digitalization is no longer a production-only affair.** Prioritized objectives span customer experience, product/service innovation, quality, and efficiency.
- ▶ **Digital use cases are predominantly in the proof-of-concept stage; rollouts are still limited.** Companies are pursuing multiple use cases, with a common focus on transparency of performance.
- ▶ **Although mainly committed to digital transformation, managers see challenges ahead.** Companies need to overcome several "balancing" challenges to start achieving impact at scale.

Digitalization will impact the core value of machinery companies

Interviewed managers of machinery companies expect significant impacts from digitalization, not only in regard to technology challenges, but also with respect to fundamental shifts of profit pools (e.g., from products to digital services/after-sales) and new digitally enabled customer interactions (e.g., digital channels, virtual collaboration). But digitalization will have an even deeper impact on the core value of machinery companies—their engineers. To master the digital transformation, leading players need to develop and integrate a broad range of new talents with new digital competencies such as data science, digital product management, or IIoT platform architecture. While most participants ranked the competency gap as the most significant impact, only a few leading players have started to develop and integrate these new digital/Internet talents. The results of our survey and discussions with machinery companies across Europe show that executives are highly aware of this challenge. Nevertheless, its importance is often underappreci-

ated. In the coming years we expect the talent gap to become one of the key challenges of digital transformation, since the demand for digital talent will significantly outstrip market supply. Especially for mid-sized European machinery companies, it will result in a war for talents against such dominant digital players as Google, Facebook, Apple, and Amazon.

Expected impacts of digitalization on machinery companies

What are the most significant impacts of digitalization for your company within the next 3 years?

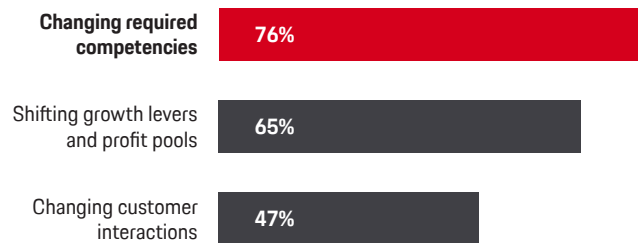


Figure 2

(Percentages, multiple answers were possible, max. 3)

Digitalization is no longer a production-only affair

Efficiency-centered digitalization has been replaced by a more holistic view, extending to growth and customer experience opportunities. Machinery industry managers interviewed in the survey are currently striving for gains in all three strategic dimensions, with the strategic area of customer interactions ranked as the top priority, followed by growth opportunities and efficiency gains. In conclusion, the results show that machinery companies are exploiting digitalization to leverage existing strengths (e.g., customer intimacy, quality, and innovation) while simultaneously addressing challenges (e.g., complexity, flexibility, and costs).

For example, 83 percent of respondents ranked the improvement of customer service as a top priority. While customer intimacy is already recognized as a core strength of European machinery companies, the survey results show that the majority of companies are aiming to increase customer satisfaction through digitally enabled interactions. Secondary objectives include the streamlining of complexity and reduction of costs through automation.

Digitalization objectives and prioritized use cases

What are the primary* objectives within the digital transformation of your company?

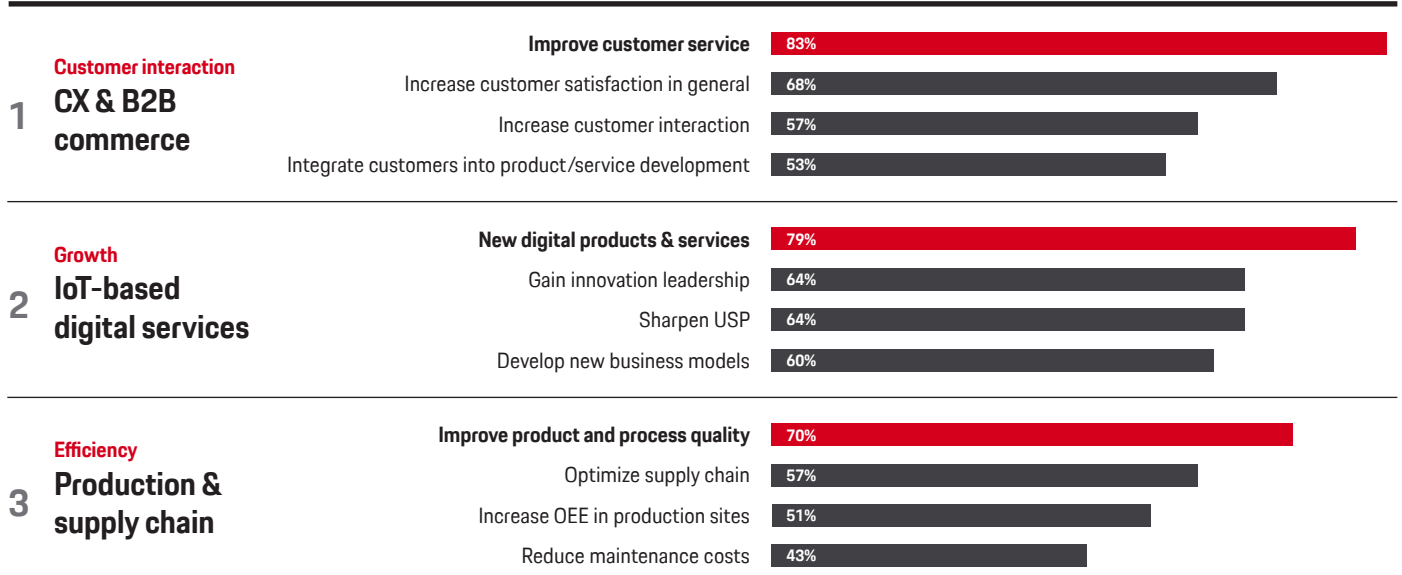


Figure 3 (Percentages; participants prioritized topics from "1 – very low" to "5 – very high") * Use cases (bars on the right) prioritized as "high" or "very high"

Digital use cases are predominantly in the proof-of-concept stage; rollouts are still limited

On average, 67 percent of all respondents claim to having either planned, conceptualized, piloted, or implemented digitalization in one or more of the following three industry segments: production and supply chain, IoT-based digital services, and B2B commerce (Figure 5). Yet, only 12 percent have implemented and rolled out digital use cases within their organization. The highest-ranked digital use cases in each of the three clusters reflect industry-wide trends, but also include underexploited digital initiatives such as data-driven process optimization. The most common of these address performance transparency, remote monitoring, process control, and online sales.

Both the results of the survey and current project experience reveal that successful deployment is largely driven by a holistic approach as well as guidance that interlinks use cases and fosters best practice sharing. Furthermore, quick test-and-learn cycles for prototypes and pilots are essential. Although European machinery companies have strong knowledge about hardware prototypes, new capabilities are needed to pilot Industrial IoT use cases. Leading companies started early in building these use cases and can now benefit from more advanced maturity levels regarding their implementation.

Although predominantly committed to digital transformation, managers see challenges ahead

In addition to "changing required competencies" as the strongest impact of digitalization on their company (Figure 2), par-

ticipants ranked issues of new talent as the next biggest challenge. With the same priority, machinery executives also ranked ambidexterity as a core challenge for future success. Ambidexterity refers to an organization's ability to be efficient in the management of today's business and adaptable in coping with tomorrow's changing demands. More specifically, the challenge for incumbent machinery companies is to balance existing core business/operations with entirely new, digitally enabled products, services, and business models. Furthermore, the survey results reflect our observation that the majority of machinery companies are behind in terms of organizational readiness, whereas the leaders of this branch have already incorporated agile innovation structures into their core organizational processes and mechanisms.

Key digital transformation challenges for machinery companies

What are the biggest obstacles your company is facing regarding the digital transformation?

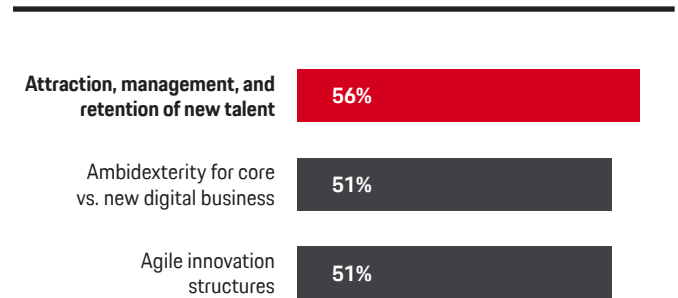


Figure 4 (Multiple answers were possible, max. 3)

Stages of digital use case adoption and implementation

What stage are you at regarding the adoption of IIoT and B2B use cases at your company?

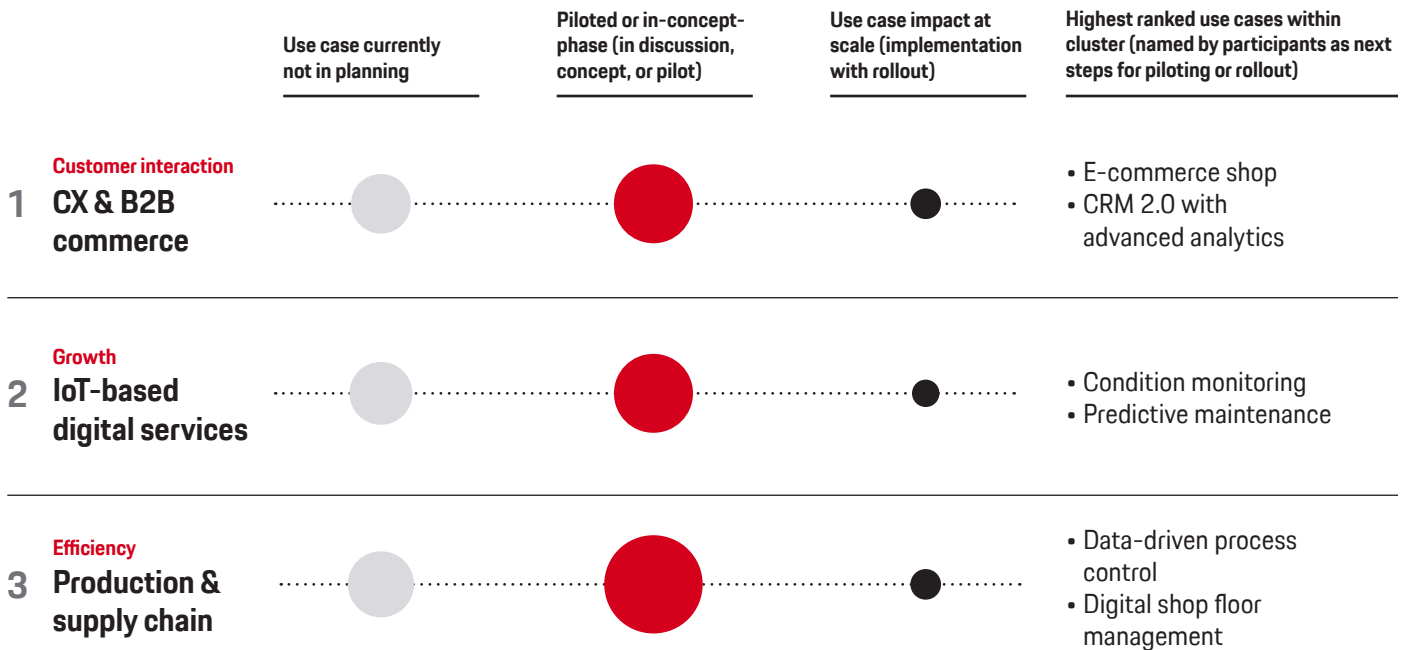


Figure 5 (Size indicates relative number of mentions. Participants prioritized use cases into following stages: "currently not planned," "planned," "conceptualized," "piloted," and "implemented")

Conclusion

The survey concludes that C-level management recognizes digital transformation as imperative for the future, with digital initiatives expanding across efficiency, growth, and customer experience. However, most machinery companies are still in the proof-of-concept stage and have not exploited digitalization's full potential.

To become digital leaders in their respective industries, machinery companies should focus on:

- ▶ **Exploiting Industrial IoT opportunities beyond production-centered digitalization initiatives**
- ▶ **Shifting efforts from operational excellence initiatives to mastering digital excellence**
- ▶ **Advancing B2B commerce and fostering new forms of customer interactions across all touchpoints**
- ▶ **Following a bolder, more highly structured, people-centric digital transformation approach, driven by the CEO**

The following chapters substantiate these imperatives and draw a holistic picture of the most relevant digital opportunities for machinery companies.

Survey details

The survey was conducted in October of 2017 among 50 managers of leading German, Swiss, and Italian machinery companies.

Interviewed company types included component suppliers (26 percent), machinery OEMs (46 percent), integrated solution providers (10 percent), and other industrial service specialists (18 percent).

Interviewed companies revenues ranged between <€100 million (33 percent), €100–€500 million (28 percent), €500–€1,000 million (10 percent) and >€1,000 million (29 percent).

3 Industrial IoT

Reflecting on the endless number of conference panels, media reports as well as scientific and technology vendor publications on the topic, one gets the impression that everything has been said about Industry 4.0 (or Industrial IoT, thus named for its broader scope). Yet only a small number of machinery companies have exhausted the potential of the Industrial IoT. The success of leading companies stems from a holistic approach of piloting, connecting, and deploying digital use cases across their value network. The majority of manufacturing companies are still new to digitalization and IIoT value creation, often too production-centered, and cyclically stuck in the pilot stage. Below, Porsche Consulting offers four situational analysis questions to facilitate an effective adoption process and help businesses exploit Industrial IoT's full potential.

3.1. Industry 4.0 implementation

How can we close the gap between pilots and deployment with impact at scale?

3.2. Mastering digital operational excellence

How can we leverage the increasing amount of data created across our value chain?

3.3. Digital quality management

How can we improve product and process quality to meet customer demands while optimizing cost and yield?

3.4. Product and service innovation

How can we monetize new digital service opportunities that arise from Industrial IoT advances, even as a supplier?

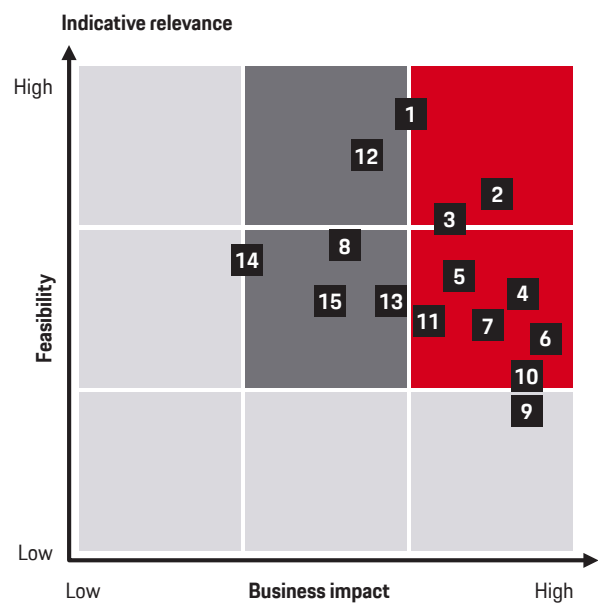
The following subchapters draw a holistic picture of Industrial IoT opportunities and provide recommendations for finding answers to these questions. Chapter 3.1 highlights the top fifteen efficiency use cases currently piloted in production and supply chain environments and lists the most common deployment pitfalls to avoid. The digital thread and digital twin, as described in chapter 3.2, herald a new age for realizing cross-value chain opportunities, while chapter 3.3 explains how machine-learning algorithms can boost quality management. Finally, chapter 3.4 outlines how machinery companies can exploit data-driven services for top-line growth based on new pricing models and how both suppliers and OEMs can reap the benefits from service opportunities.

3.1 Industry 4.0 implementation – from pilots to impact at scale

Porsche Consulting has gained extensive insights from working closely with machinery companies, including several brands within the Volkswagen Group, in the process of IIoT adoption. Figure 6 – highlights the top fifteen use case clusters currently piloted by hardware-driven companies in their production and supply chain environments.

Top 15 industrial IoT use cases

for production and supply chain



- 1** Digital performance management
- 2** Predictive maintenance
- 3** Digital quality management
- 4** Digital thread/digital PLM
- 5** Smart energy management
- 6** Demand & supply forecasting
- 7** Smart production planning
- 8** Human-robot collaboration
- 9** AI-driven supply chain & logistics optimization
- 10** Data-driven process optimization
- 11** Digital yield optimization
- 12** Digital shop floor management
- 13** Autonomous flow of materials
- 14** VR trainings production & logistics
- 15** 3-D printing for spare parts

Figure 6

Low Medium High

Optimization of OEE, reduction of operational costs, increased process efficiency, and quality and flexibility are essential benchmarks for Industrial IoT implementation. Digital Performance Management (also known as asset management) is a common base case used to support each of these goals by bringing in required machine performance transparency and control.

As reflected by our survey (see chapter 2), many machinery companies find themselves stuck in the pilot phase of one or more IIoT solutions, unable to realize significant, visible results at scale. Successful, company-wide rollouts are still largely limited (in our survey less than 12 percent). As identified by Porsche Consulting's digital transformation projects, the most common pitfalls specific to the machinery industry are:

- ▶ **Understanding, strategic baselining, and leadership commitment:** a lack of overall understanding of Industry 4.0, lack of vision, undefined data strategy, lack of resources and allocated budgets, insufficient leadership commitment
- ▶ **Use cases and piloting:** lack of approach for use case assessment and prioritization, internal roadblocks due to data silos and security concerns
- ▶ **Capabilities and infrastructure:** lack of digital competencies, collaboration, and communication; missing implementation of agile development approaches; insufficient partner integration; use of legacy infrastructure
- ▶ **Deployment approach:** lack of approach for use case deployment and rollout including knowledge sharing, lack of dedicated deployment resources, missing stringent project management

Understanding, strategic baselining, and leadership commitment

Although the vast majority of managers affirm the relevance of Industrial IoT, many fail to create a clear vision and coherent plan for its deployment. The reason is a lack of understanding of the digitalization impact in general and Industrial IoT technologies in particular. Consequently, their businesses often reflect disparate digital activities without overarching objectives or realized synergies from the new initiatives. Another shortcoming is the fact that some executives take a functionally focused approach, delegating digital initiatives to single business units (SBUs) or departments (e.g., IT), resulting in isolated transformation. Successful, company-wide IIoT exploitation needs 100 percent

leadership commitment to create a burning platform for change, a bold strategy, and a robust but dynamic deployment plan with dedicated and knowledgeable teams that integrate digital technology know-how with domain expertise.

Use cases and piloting

Many machinery companies following the narrow, department-specific pilot approach, often transforming only certain functions within each SBU, such as performance tracking within one production plant. The selection process for relevant digital use cases, especially around Industrial IoT, should instead follow a holistic approach by capturing opportunities in all three strategic areas of growth through new digital products and services, efficiencies along the entire value chain, and new forms of customer interaction. This comprehensive view helps companies better assess the real value and relevance of lighthouse use case transformations in contrast to single use cases. Data security concerns are also common hurdles in the early adoption stages, often a discouragement to transformation initiatives. But while security and digital integrity are always important considerations, they should not stifle ingenuity and progress early on.

Capabilities and infrastructure

To bridge the gap between piloted use cases and implementation at scale, machinery companies need to focus on two areas—capabilities and infrastructure. On the one hand, companies need a scalable IIoT platform as the foundation to scale pilots. On the other hand, they need active partner integration since most of the enabling technologies (e.g., data analytics) should be supplied externally. Digital capabilities are predominantly new digital competencies (e.g., data science, connectivity) but also include new ways of working (e.g., agile development) to foster collaboration and increase speed. In addition to running pilots, machinery companies should start to design an overall governance framework to prioritize new digital initiatives, steer the rollout of successful pilots, and increase the speed of future decisions, such as budget allocation.

Deployment approach

Once clients are successful with a focused SBU transformation, they frequently struggle with how to implement on an organizational scale and realize the full benefits of Industrial IoT use cases. Assuming sufficiently deployed resources (investment and manpower) as a base requirement, there is no one-size-fits-all deployment approach for successful, large-scale Industrial IoT deployment. There are, however, two commonly used deployment approaches that have proven suitable for scaling up successful pilots. The first is to share best practices between all leading plants, with parallel rollout initiatives. The second

approach recommends that the rollout occur successively, by segment, with one overall strategic plan to identify and test top fields of action (for more details see chapter 5.3).

Key takeaways

Many machinery companies have initiated the digital transformation process with department and/or function-specific Industrial IoT pilot projects, predominantly within their production facilities.

Most initiatives become sidelined in the pilot phase. Full deployments with scalable impact are less common in the machinery industry.

Common pitfalls of Industrial IoT projects include a lack of clear understanding, misguided focus on technologies instead of pain points, too-narrow use case exploitation, insufficient project steering, and an unclear deployment approach.

tion can enable leading companies to achieve 15 to 30 percent revenue increases while reducing operational costs by 20 to 40 percent¹. The key to such a quantum leap is end-to-end digital information flow along the entire product lifecycle, known as the “digital thread.” However, a full digital thread can take years to implement completely, reinforcing the urgency to start the process of transformation as soon as possible.

Digital thread – the backbone for mastering digital excellence

Digital thread refers to the digitalization and interlinkage of product data and related information—from R&D, design inception, and prototyping to manufacturing and end product in service. As illustrated in figure 7, the key to a successful digital thread is the ability to build a “single source of truth” that provides consistency, traceability, and reusability of digital product information throughout the entire product lifecycle. Furthermore, the digital thread is an enabler to break up silos and integrate steps horizontally. Hence, machine builders can return to “day one” where customers and their pain points were at the center of a company’s business, instead being restricted to organizational silos. The results are improved hit rates, increased speed of interactions and decisions, improved flexibility, and higher transparency for all stakeholders.

Bausch+Ströbel, for example, the special-purpose machine manufacturer, expects an increase in engineering efficiency of at least 30 percent by 2020 as a result of its comprehensive digital thread—from R&D and design functions to operations. GE has also realized an 18 percent increase in equipment effectiveness at its Pune factory location due to digital thread technology.

3.2 Mastering digital operational excellence with digital thread and digital twin

In the past, machinery companies have been devoted to operational excellence, focusing on optimizing their physical assets, but recent trends now necessitate digital excellence. Digitaliza-

The digital thread as the backbone of tomorrow’s digital excellence

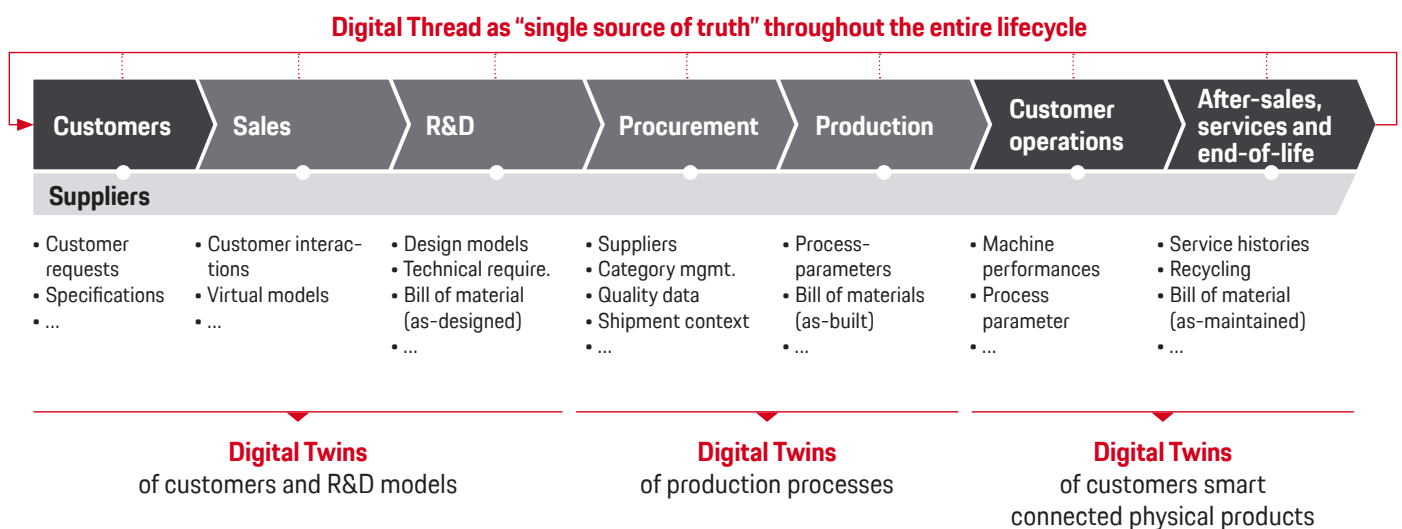


Figure 7
 1 – Based on Porsche Consulting project experiences and analysis of third-party data including IDC Future Scope: Worldwide Digital Transformation, PWC: 2016 Global Industry 4.0 Survey, and benchmarks from several consulting peers

The digital thread starts with the product's digital design of the product (e.g., CAD model or bill of material), passes through a digitally steered and controlled manufacturing process (e.g., machine parameters), applies to the machine's in-the-field usage (e.g., performance data) and service (e.g., installed spare parts), integrates the digital information of produced products (e.g., yield quality), and finally ends with product recycling (e.g., reused parts). To explore and identify opportunities within each of these steps, machinery companies should analyze the entire digital thread along the following two dimensions:

- ▶ **Vertical gains:** solutions within silos, where insights can be used to optimize single value chain steps. Exemplary use cases are dynamic bill of material (BOM) for engineering, automated sourcing of parts with long lead times, prediction of assembly-process issues via simulations, and recording and updating BOMs of installed machines as they are maintained.
- ▶ **Horizontal gains:** solutions that leverage information across silos and enable stronger, cross-functional optimizations that involve multiple stakeholders. Exemplary use cases are holistic digital quality management, traceability of product data throughout the lifecycle, supply chain optimization, and supplier development.

These digital thread opportunities can extend to an even higher level when machinery companies create dynamic digital models of their physical entities, enabled by the IIoT and advanced simulation technologies. These models are recognized as digital twins.

Digital twin – the new enabler of smart, connected service offerings

A digital twin is a virtual instance of a process, product, or service. Both the physical and the virtual assets are interlinked in In 2017 the digital twin was named one of Gartner's top ten strategic technology trends. Thomas Kaiser, SAP's senior vice president of IoT, explains that "digital twins are becoming a business imperative, covering the entire lifecycle of an asset or process and forming the foundation for connected products and services. Companies that fail to respond will be left behind." Both the digital thread and the digital twin are not mere concepts but crucial strategic journeys with several intermediary steps and junctions. Figure 8 illustrates exemplary companies along a typical path by which machinery companies navigate the landscape of these opportunities.

Strategic path for digital twin exploitation

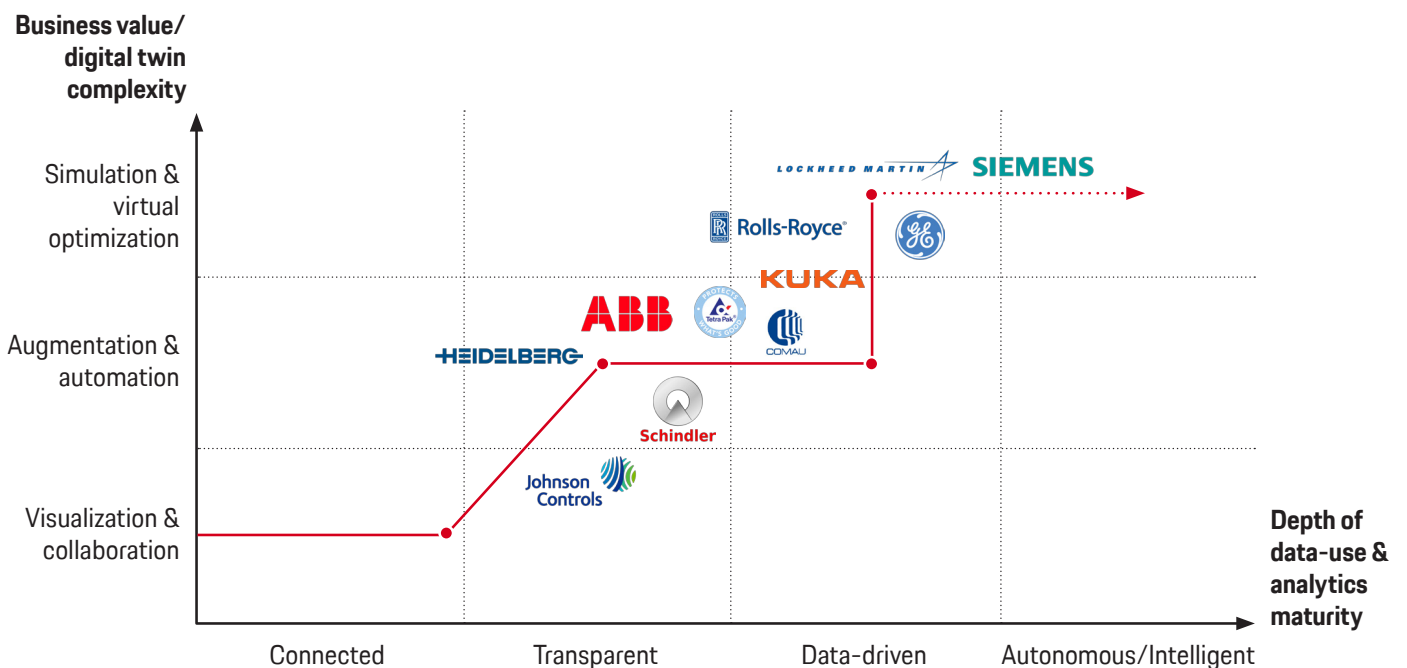


Figure 8 Typical path of industrial companies Logos Exemplary companies

Digital twins have the potential to radically change every SBU including design, sourcing, manufacturing, sales, and maintenance within machinery industry companies. To leverage the full potential, machinery companies need to exploit three digital twin archetypes:

- ▶ **R&D twins:**
changing the way products are designed
(innovation, speed, quality)

- ▶ **Process twins:**
changing the way products are manufactured
(cost and quality)

- ▶ **Product twins:**
changing the way products are utilized
(productivity and flexibility)

While applied digital twins are still scarce, and technologies continually evolve, leading companies are already using digital twins to understand operations better, get closer to customers, and transform their own businesses gradually. Figure 9 illustrates exemplary business values based on product twin deployments.

Key takeaways

Leading companies can potentially achieve simultaneous reductions (20 to 40 percent) in operational costs and increases (15 to 30 percent) in revenues.

To unlock innumerable product-life-cycle opportunities, digital twins are becoming a business imperative by enabling machinery companies to better understand operations, get closer to customers, and transition into offering integrated hardware, software, and digital services.

Industry incumbents need to shift the focus from operational to digital excellence and focus on the digital thread as a foundation for future digital machinery competencies.

As a “single source of truth,” the digital thread enables data-driven optimization of processes, costs, and quality by providing consistent, traceable, and reusable data information.

Digital Twin: Impact areas and exemplary business values

Installed base



Digital Twin

- Physical instances of a machine type with different locations and customers
- Platform manages portfolio of digital twins with overarching analytics
- Digital twins are connected to physical instances in real-time via IoT and sensors

Impact areas

- Flexibility
- Production efficiency
- Quality
- Customer efficiency
- Services level
- New growth opportunities

Exemplary business value

- Reduce time-to-market for new products through simulations
- Update and upgrade machines “over-the-air”
- Improve performance of manufacturing processes
- Reduce operations and process variability
- Improve design based on insights from real (actual) usage
- Detect quality issues and trace back to suppliers or batches
- Real-time performance management and optimization
- Immersive human-machine collaboration
- Improve customer support through remote access
- Proactively and more accurately determine quality issues
- Remote expert support on real-time digital model
- Predictive maintenance and performance-based business models

Figure 9

3.3 Boosting quality management through machine learning

To maintain strong positioning and expand the customer base in an increasingly competitive environment, European machinery companies have to meet the highest quality and reliability standards. This applies in particular to those companies that sell their machinery to customers in safety-critical areas or with direct end-customer contact. Most machinery customers from automotive, consumer goods, semiconductor, or pharmaceutical industries have error tolerances far below 1 percent or even zero-tolerance policies that are passed up the chain to their suppliers. At the same time, machinery products and manufacturing processes are themselves becoming increasingly complex and, as a result, a single operational activity can simultaneously affect quality, cost, and yield.

Machinery companies need reliable methods and processes to ensure sustainable quality without losing performance. Traditional quality management strongly relies on manual inspections by workers, often with inconsistent skill levels. Manual inspections may handle tasks flexibly but are error-prone and not scalable. Even highly automated production systems lack systematic data interlinkage and analysis. This pressing need was also reflected by our survey participants, who ranked improved product and process quality as the most important use case cluster within the production and supply chain area.

Driving digital quality control with machine learning

Advanced analytics—machine learning in particular—provide an innovative approach to digital quality management. With these technologies, machinery companies are now able to address and optimize all relevant quality dimensions at the same time:

- ▶ **Improved quality** through new insights and data-driven optimizations
- ▶ **Reduced costs** through automated quality testing and augmentation of manual work
- ▶ **Enhanced yield** through pattern recognition and root-cause analysis along the digital thread
- ▶ **Increased speed** through online interaction with customers, suppliers, and other stakeholders

This is enabled by supervised machine learning techniques capable of learning from relatively small training data sets. The algorithms act like virtual engineers with the same decision behavior as their human counterparts but with the efficiency advantages of machines. Figure 10 illustrates how these advantages can be leveraged and translated into significant business potentials:

Exemplary business outcomes through applied machine learning

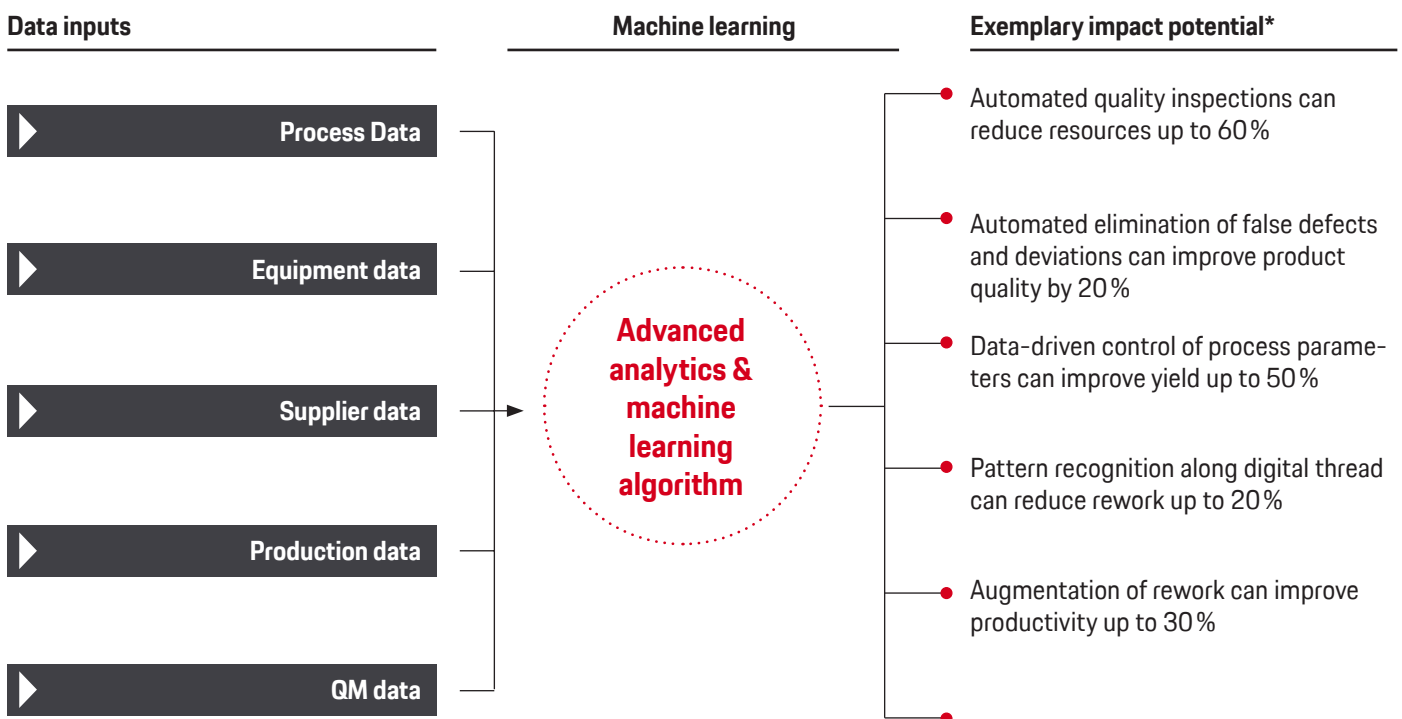


Figure 10

* Source: Porsche Consulting project experiences, Bauernhansl, M. ten Hompel, B. Vogel-Heuser (Hrsg.): Industrie 4.0 in Produktion, Automatisierung und Logistik (2014), National Institute of Standards and Technology: Focus Group: Big Data Analytics for Smart Manufacturing Systems

Exemplary applications of machine-learning-based digital quality management

The advantages of systems based on machine learning become even more evident in the case of real-time automated quality control along production lines. Until now, this type of inspection required steep investments in equipment, long setup times, and limited tolerance parameters. Modern machine-learning systems are capable of performing visual inspections and quality checks in near real time, and are able to manage a wide variety of products with intelligent filters. These machine learning systems enable multiple applications (Figure 11) while remaining affordable for companies of any size due to significantly lower costs than traditional methods.

Key takeaways

Machinery businesses face increasingly higher quality requirements from customers and require more reliable methods to ensure sustainable quality without losing performance.

Traditional quality management approaches carry significant shortcomings in manual inspections and lack root cause analysis, while machine-learning-based quality control enables synchronized optimization of quality, costs, and performance.

In-line and automated production quality control systems pave the way for myriad efficiency and quality-increasing use cases with up to 60 percent reduced FTE and improved quality by up to 20 percent.

Applied machine learning use cases for automated quality control

Machine learning based classification of parts via camera system ("o.k.," "rework," "not o.k.," and "unknown patterns")

Machine-learning-based dynamic adjustment of process parameters via input from cameras and codified problem-solving strategies

Automated routing and guiding of workers with real-time information to conduct rework based on AI-engine recommendation

Machine learning algorithm to detect anomalies from wireless ultrasonic sensors to identify patterns & forecast quality issues

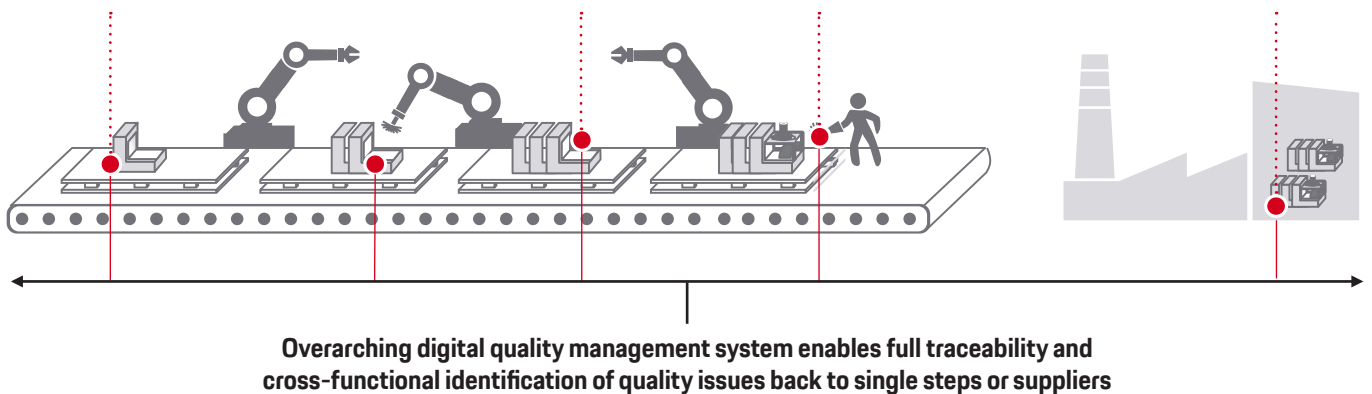


Figure 11

3.4 The data-driven service opportunity

After-sales services are an attractive growth area in the machinery industry. Maintenance services, spare parts, consumables, and modernization usually generate higher margins than equipment sales. As described in previous chapters, the recent advances in Industrial IoT, ubiquitous connectivity, and advanced analytics pave the way for a new era of industrial services. Reduced costs in service delivery and closer client relationships are the key areas to benefit from these new, data-driven service opportunities. Participants in our survey seemed to be aware of these opportunities, because they named new digital services the highest priority of their growth ambitions (Figure 2).

Figure 12 provides an overview of currently piloted and fully implemented smart, data-driven services. The multitude of new services heralds a paradigm shift toward service revenue structures and away from traditional product-centric services.

Various smart industrial companies have already embraced these new service opportunities.

- ▶ **Atlas Copco:** The global manufacturer of industrial tools and equipment significantly increased orders for their mining business by 33 percent between 2016 and 2017 by launching a telematics solution, which provides clients and third-party stakeholders with real-time conditional data from the connected machines and suggests actions to improve uptime.
- ▶ **SKF:** One of the global leaders for bearing solutions provides bearing solution packages comprised of hardware, data services, and predictive maintenance services, which result in higher uptime and at least 30 percent lower total cost of ownership compared to competitor solutions.
- ▶ **La Marzocco:** The coffee machine company introduced a new espresso machine as a service business model to its global barista clients and expects an associated revenue increase of 40 percent within the next three years. The service model connects and summarizes existing legacy coffee machine data to provide the manufacturer and customers with information on health, proper usage, water and power consumption, and machine lifetime, across any generation.

The extended service opportunity for machinery

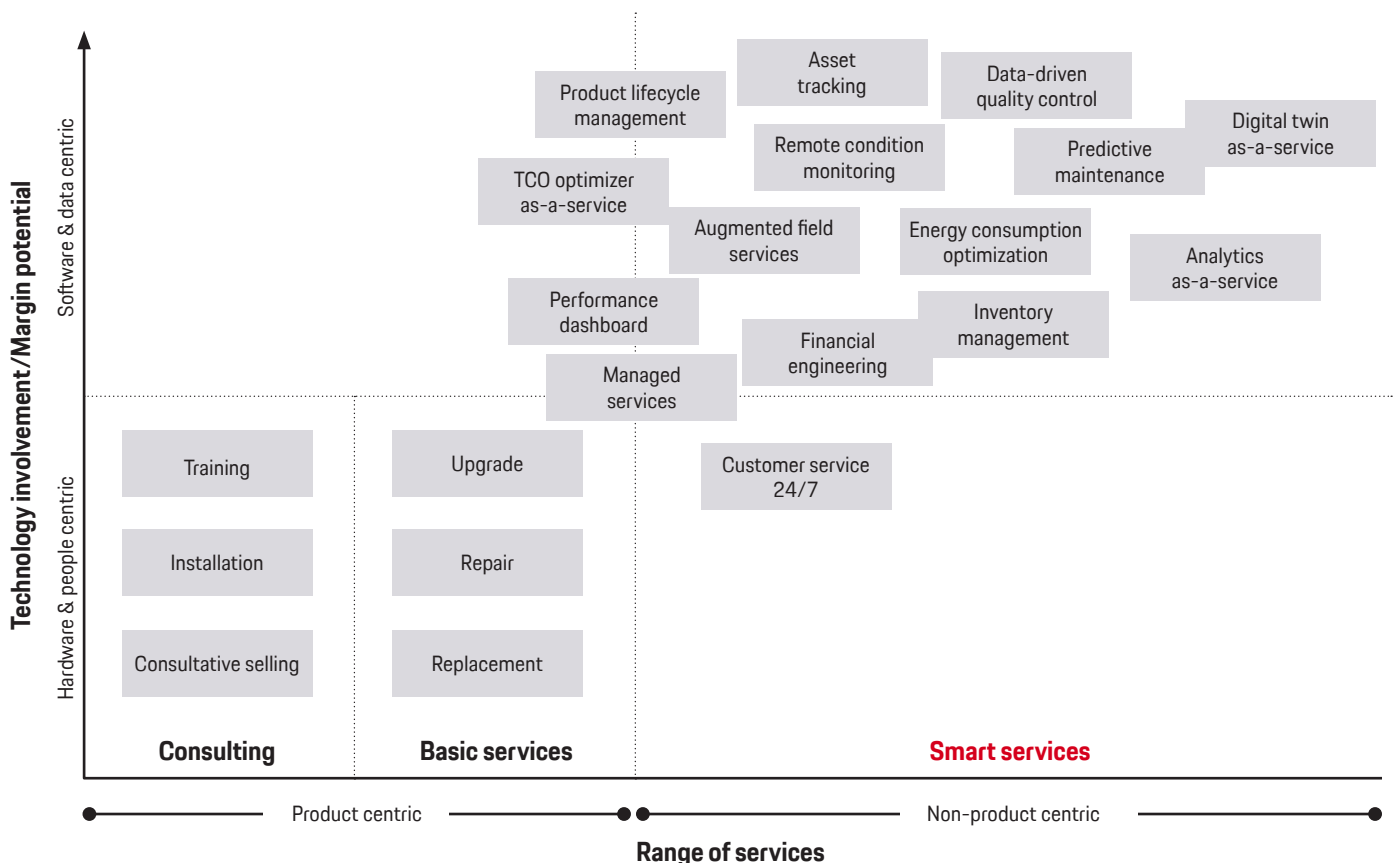


Figure 12

(not exhaustive)

Shifting business and pricing models

In addition to the service revolution, there has also been a gradual, albeit radical shift in business and pricing models from ownership based to outcome based (Figure 13). According to our survey, 63 percent of machinery managers interviewed regard the shift of growth levers and profit pools as one of the most significant impacts of digitalization to their businesses.

Both sellers and buyers are driving this shift. Whereas machinery companies strive for new, recurring, and profitable revenue pools to compensate stagnating margins in their core business, buyers are seeking opportunities to optimize cash flows (from Capex to Opex) and avoid risks. Interest in performance-based business models is rising throughout Europe. As we see it, however, neither usage-based nor performance-based business models are ends unto themselves. Companies need to understand if the approach truly solves their customers' pain points and provides long-term competitive advantages.

Relay, a leading European full-stack IoT provider, is an advocate for outcome-based business models, focusing on guaranteed business outcomes (backed by Munich RE) along three dimensions:

- ▶ **Reduced costs**
Ensure expected savings
(e.g., minimize energy consumption)
- ▶ **Optimized productivity**
Ensure increased output
(e.g., improve OEE)
- ▶ **New digital revenues**
Ensure expected new revenues
(e.g., predictive maintenance-as-a-service)

Shifting business and pricing models

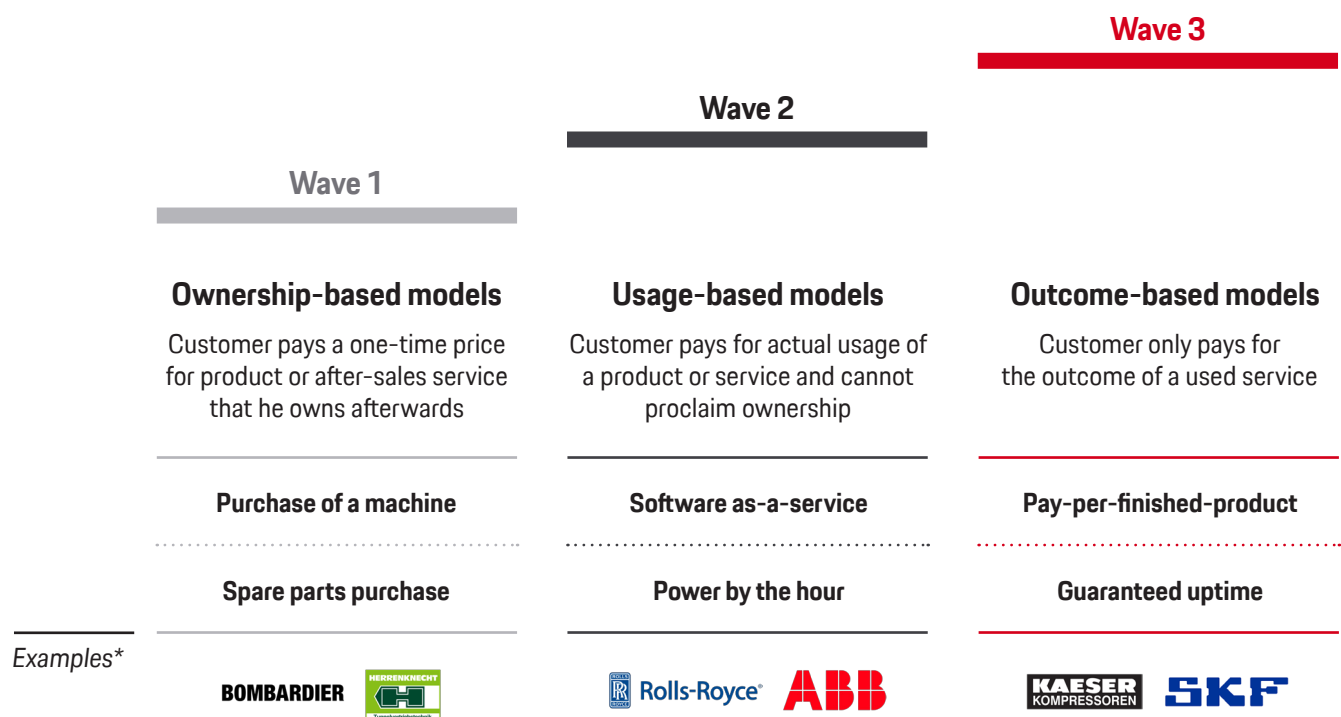


Figure 13

* Companies exemplary for business model waves

A prerequisite to outcome-based business models are shared-value drivers (between vendors and buyers), which the vendor can actually influence based on technical services. The most obvious value driver of outcome-based business models is equipment availability. Unplanned downtime is one of the biggest operational cost drivers for machinery customers. A recent study by Stratus revealed typical costs of €25,000 to €42,000 per unplanned downtime hour for many industrial settings. A few companies even report costs of over €210,000 per hour. Hence, addressing unplanned downtimes is of paramount importance for new digital services, such as real-time condition monitoring or predictive maintenance. If such services were able to increase equipment availability by even 0.5 percentage points, the impact on costs would be huge. Assuming that a 99 percent equipment availability equals fifty hours of unscheduled downtime at average costs of €25,000 per hour, an uptime increase to 99.5 percent would result in annual cost savings of €630,000. Unsurprisingly, machinery customers are open to long-term digital service contracts that support achieving such savings.

Service options for OEMs

As illustrated in Figure 14, there are two basic options for machinery companies to capture new digital service values. Option A (“value climbing”) depicts the most common approach to strengthening the core business, while option B (“moon shooting”) is applied by only a few industrial players with high digital maturity. The value climbing approach supports the transformation of exist-

ing machinery businesses into a hybrid of hardware, software, and new digital services. This approach is a reasonable starting point for digital transformation, beginning with digitalizing a company’s own hardware and followed by developing a digital thread (chapter 3.2) for the eventual deployment of new digital services based on new business models to exploit recurring revenues sources.

The moon-shot approach is not necessarily more successful or recommendable. Successful platform businesses can be highly profitable; however, many roadblocks exist on the path to mastering new technologies, including challenges to core competencies, ecosystem management, multichannel marketing, and innovation speed. These challenges are greater than with the value-climbing approach, and required investments are significantly higher.

Service options for suppliers

Suppliers of machinery OEMs are also beginning to recognize the need for digital services. Since suppliers lack end-customer access, however, making use of digital-service value pools is far more difficult. Based on client projects with machinery suppliers, Porsche Consulting has identified several options for suppliers to integrate digital service opportunities. Figure 15 summarizes four generalized options to demonstrate increased digital maturity and the resultant captured value.

Strategic options for OEMs to leverage the digital service opportunity

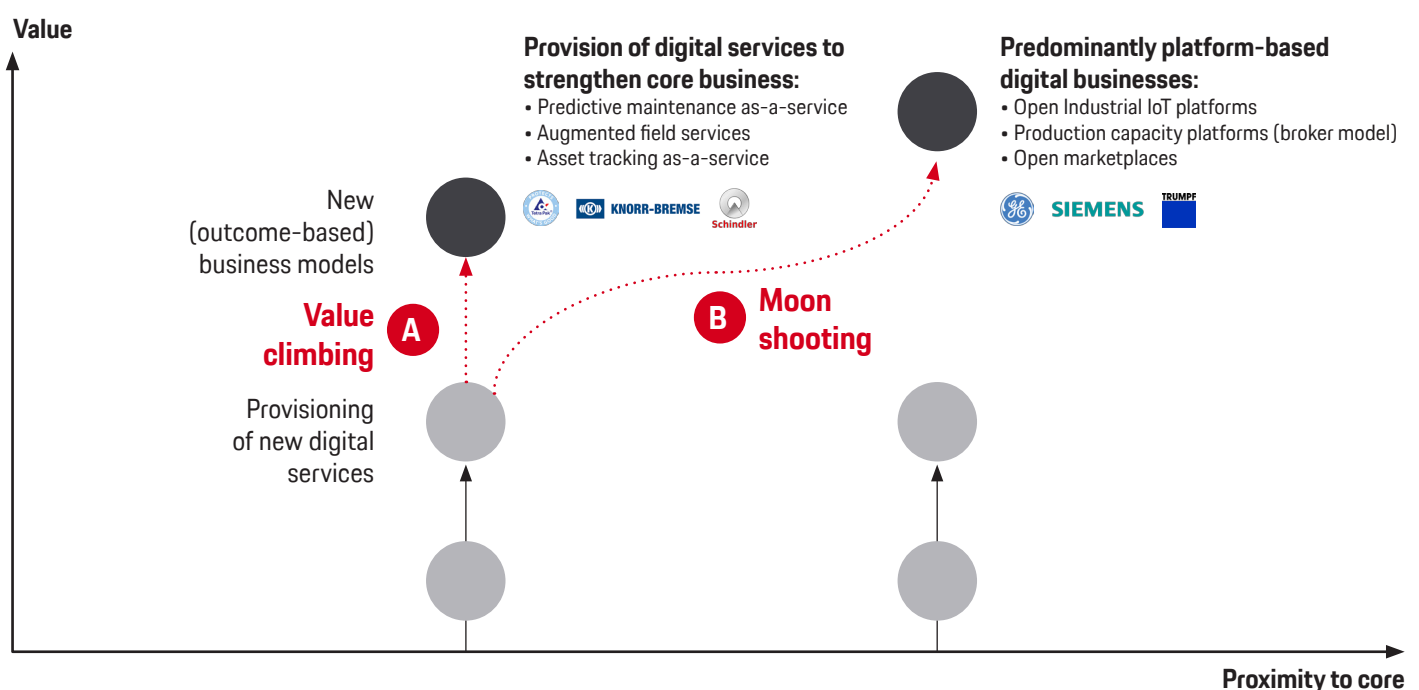


Figure 14

Strategic options for suppliers to leverage the digital service opportunity

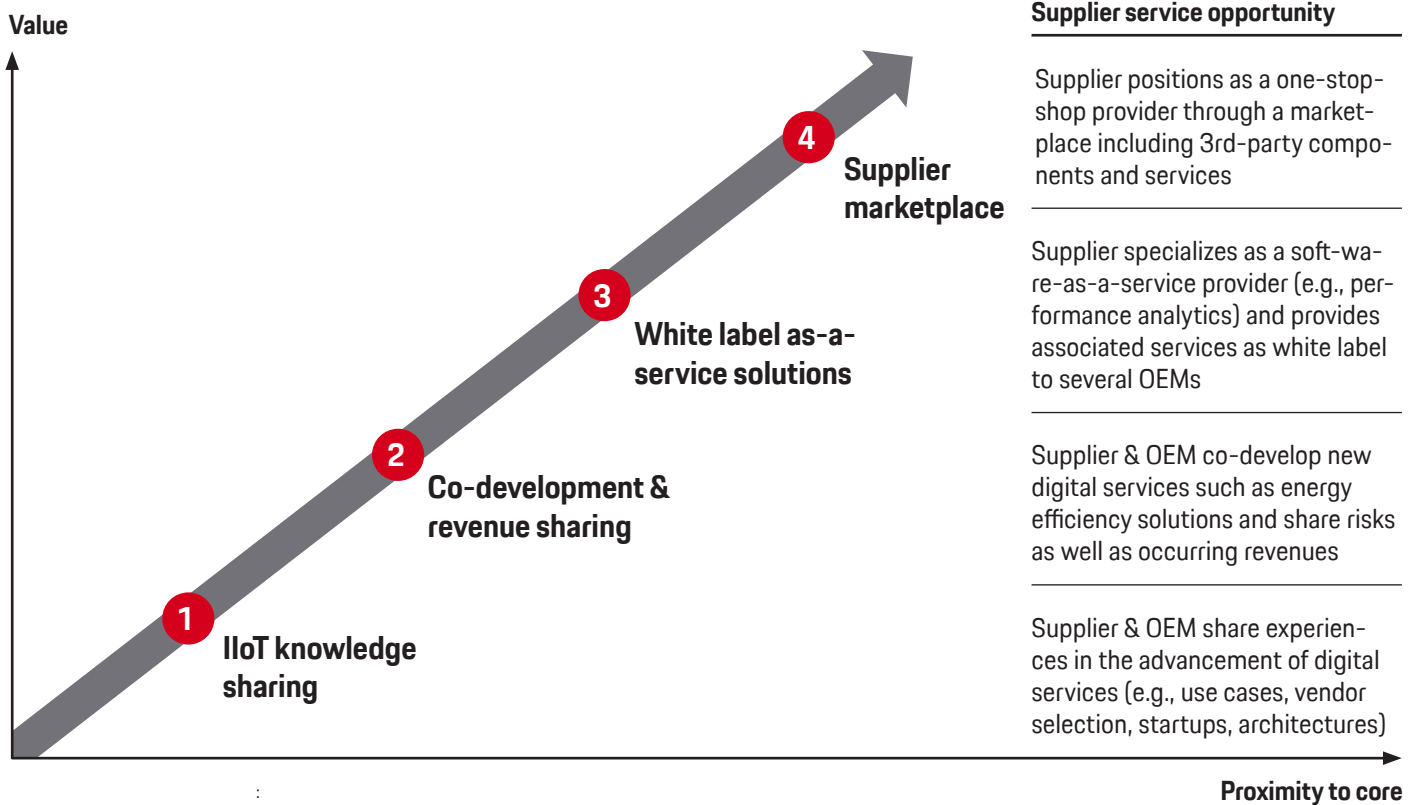


Figure 15

Key takeaways

Digital services pose a great opportunity to machinery companies for profitable top-line growth, reduced costs of service delivery, and closer relationships to customers. Various machinery businesses are already seizing the new service opportunity.

The exploitation of new service potentials coincides with a shift in business models from ownership-, to usage-, to outcome-based models. To leverage this industry trend, machinery companies must address their customers' biggest pain points, which are predominantly centered on the avoidance of unplanned downtime.

Machinery companies have two main positioning options within the industrial ecosystem: either climbing up the value chain to strengthen the core business or following a moon-shot approach that leapfrogs existing value chains and enables completely new profitability dimensions.

Despite the disadvantage of a lack of end-customer access, suppliers can also reap benefits from digital services based on four options with increasing value: knowledge sharing with OEMs, co-development of new services, white label as-a-service solutions, and supplier market places.

4 Next generation of B2B commerce

Based on project experiences and interviews with machinery industry C-levels, we have observed a tipping point in the advancement of B2B commerce. Sixty-eight percent of online business buyers consider their online vendor or current service research superior to the information from sales representatives. B2B buyers are becoming more digital, using multiple devices, conducting more online product research, and expressing more preference for self-service. The demand for digital sales channels is rising.

Nontraditional companies such as Amazon Business and Alibaba are already cashing in on B2B commerce business values with competitive digital service offerings along the customer buying journey. Machinery companies need to reinvent their sales strategy towards a customer-centric approach or risk falling behind in the industry.

Three trends are driving the need to rethink existing B2B sales

We are convinced that machinery companies can leverage existing competencies by combining modern e-commerce interfaces with in-depth consulting experience and IoT technologies to unlock massive upside potentials. Two traditional industrial equipment distributor companies, HD Supply and Grainger, have seized the new digital sales opportunity, and both report their e-commerce sales have outpaced respective offline sales. An increasing number of machinery company executives are aware of these opportunities. According to our survey, 68 percent of participants ranked B2B commerce as highly relevant. Three trends are driving the need to rethink existing B2B commerce.

► Consumerization

Influenced by B2C experiences, B2B customers have increased expectations regarding personalized sales approaches, product and service transparency, and channel flexibility.

► Efficiency

Automated processes are faster with shorter response times and highly scalable offerings.

► Servitization

Machinery company services are a major revenue source and highly profitable in general. The shift from products to solutions will further increase the importance of digital services.

Few machinery companies have started e-commerce initiatives, due to hesitation or difficulty with the implementation of customer-centric digital sales operations. Scalable potential is further diminished by the narrow perspective that e-commerce is merely an additional sales channel. Copying success stories from the B2C world and setting up web shops is not a transformational opportunity. As a result, customer impact and financial returns from most e-commerce programs are lagging far behind expectations.

The real value of B2B commerce will result from a reinvention of sales, centered on the creation of new customer experiences along the entire customer journey, combining digital and non-digital services. The following subchapter suggests a digital platform-driven approach that unlocks new sales and customer experience opportunities for machinery businesses.

4.1 The digital customer platform of the future

The next generation of B2B commerce must be a holistic platform approach along an end-to-end customer journey transformation, integrating e-commerce with interactive sales tools, mobile applications, Industrial IoT, data analytics, and digital services. The suggested approach replaces formerly isolated, mostly analog customer interactions with a central digital business platform for addressing customer needs and redefining the way business entities operate and collaborate. Four key platform areas of focus are shaping the end-to-end customer experience (see Figure 16).

Imagine a single-access point platform that allows customers to discover products in simulated production environments, conveniently place orders, track shipments in real time, obtain remote support for equipment installations, connect all machinery, monitor machine performance at any time, and order spare parts or consumables when they are needed. On the same platform, service technicians can plan service jobs, access instructions, and document their maintenance work. Such a customer platform would improve customer satisfaction, automate sales, supply processes, and provide new digital service offerings with cost-saving potential for each collocated opportunity.

Figure 17 outlines extensive possibilities for new digital sales tools and services and suggests direct, potential outcomes within each of the four areas.

The next generation of B2B commerce platforms

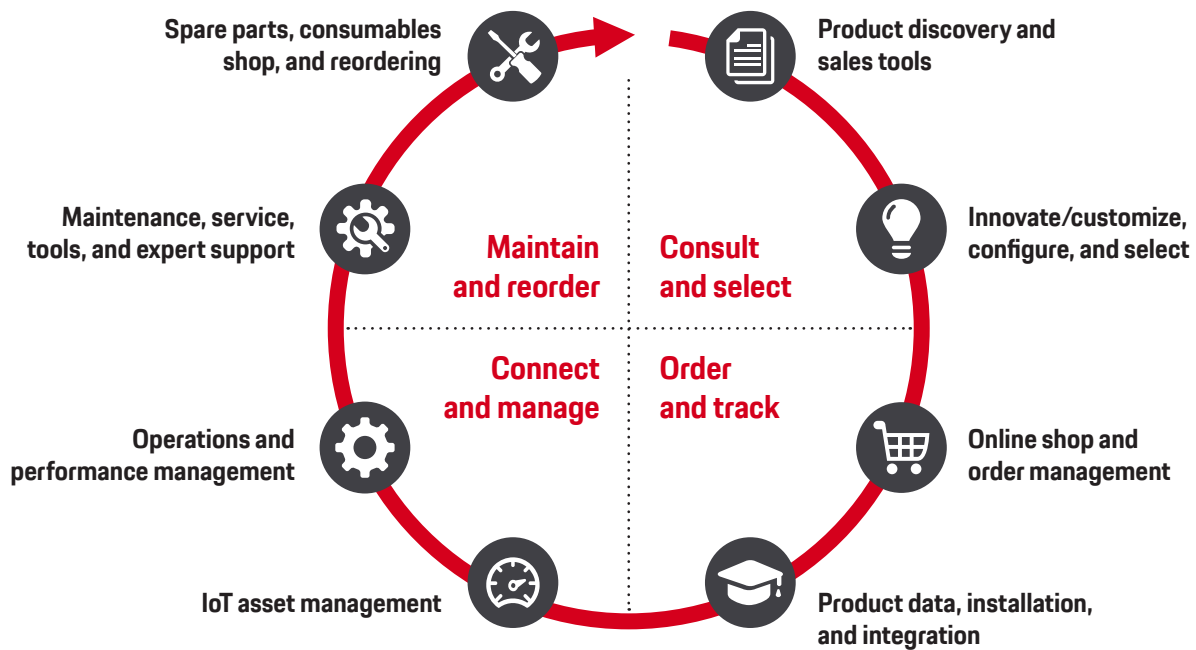


Figure 16

Use cases and impact areas along the customer journey

	Consult and select	Order and track	Connect and manage	Maintain and reorder
Exemplary tools and services	<ul style="list-style-type: none"> • Application wiki with industry know-how • Comparison tools for solutions and offerings • Virtual collaboration and co-innovation • Customization mgmt. • Solution configurators • Digital sales tool • 24/7 live support & consultation (e.g., AI-based chat bots) 	<ul style="list-style-type: none"> • Personalized online shop • Overview of quotations, real-time orders, and shipments status • Access to product data and guidance • Remote support and guidance for installation • Online trainings 	<ul style="list-style-type: none"> • Self-service customer portal • IoT-based asset and performance management • Tools and service to optimize performance • Access to digital services and contracts (e.g., condition monitoring) 	<ul style="list-style-type: none"> • Online access to maintenance plans and contracts (e.g., predictive maintenance) • Find and order correct spare parts/consumables • Automatized and predictive reordering • Remote expert support and AR-assisted service
Impact on	Conversion rates (+10–40%)	Sales process costs (-30–50%)	Long-term services channels (+30–50%)	After sales (+30–60%)

Figure 17

Consult and select

B2B buyers often find it challenging to select the right product or service and compare suppliers in a time-efficient manner across multiple criteria. Improving customer experience includes creating new tools to ease complex buying decisions and increase conversation rates. Virtual collaboration rooms enable machinery companies to enhance customer experience within the project business. They also speed up interactions with customers, suppliers, and other stakeholders as well as enable new business and service opportunities. Additionally, self-service portals allow for the exploration of solutions in different areas of application and an automatic response to frequently asked questions.

Order and track

The ordering and tracking process in the manufacturing industry remains highly analog-centric, with faxes, tables, and letters dominating order interactions between sellers and buyers. Instead, there could be fully automated order processes (e.g., personalized online shop environments and electronic-data-, interchange-based order management processes) that eliminate manual efforts on both ends, create transparency and traceability, and increase customer satisfaction.

Connect and manage

Most machinery sales activities resulting in shipped products often miss the opportunity to track usage and performance of the installed base, impeding the generation of recurring revenues. Based on smart connected devices that activate once they are shipped (through online installation routines, for example), the customer is able to track its lifetime performance through a dashboard integrated into the customer portal and, as a result, machinery companies can unlock new digital service models.

Maintain and reorder

The after-sales business has been a significant profit pool for machinery companies but has yet to be fully exploited. Spare parts orders or consumable reorders are mostly triggered by buyers (sourced from the OEM but also from third parties) and processed manually or with media frictions. Using the “connect and manage” tool within the digital customer platform, sales reps can now automatically raise after-sales demand through predictions of spare parts or consumables needs. Automated reorder processes triggered by stock sensors, for example, also enhance customer retention.

From a customer-centric platform perspective, a new digital sales strategy can lead to a plethora of innovative customer interactions for the distribution of existing products or even to entirely new business models. John Deere, for example, is

transforming itself from a supplier of agricultural machinery into a productivity partner, providing advice to farmers on seed, fertilization, and harvest timing. Trumpf has started the new venture AXOOM to develop a manufacturer-independent digital business platform.

John Deere and Trumpf are examples of industry first movers, according to a recent ICF report, since over 40 percent of machinery companies are still in the infancy stage of B2B platform innovation, having defined a strategy but not started any implementation. As of today, even Bühler AG has only deployed a small part of its promising “myBühler” platform (Figure 18).

Already implemented segment of myBühler platform

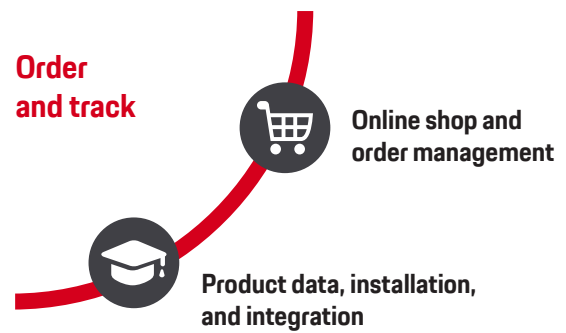


Figure 18

Key takeaways

A 360 degree digital customer platform collocates buyer-seller interactions along the entire customer journey (from product discovery to reorder). The platform format uniquely improves several business opportunities including customer satisfaction, automated sales, supply processes, and new digital service offerings.

A number of leading machinery businesses—such as Heidelberger Druckmaschinen, Bühler, Atlas Copco, and Trumpf—have taken on the B2B commerce challenge, but the majority of the industry has yet to realize and implement a platform-based model.

Path towards an integrated B2B commerce platform

Platform maturity

1 Start with the most relevant customer interfaces

- Provide smart services to solve customer pain points (e.g., solution identification, issue fixing)
- Launch e-commerce site of ready-to-sell products (e.g., spare parts, consumables)
- Integrate order management with backend ERP system
- Start to build automated interfaces toward key customers (e.g., interface to external ERP system)

2 Integrate physical assets into digital customer portal

- Integrate machines and field services through IoT technologies and sensorification
- Boost sales with advanced tools (e.g., online configurator, CRM analytics)
- Enrich customer experience (e.g., real-time condition monitoring, VR-based app)
- Push efficiency through automations, self-service tools, and backend integrations

3 Consolidate services to build holistic business platform

- Integrate services into holistic B2B commerce platform
- Build an ecosystem of partners to enhance platform value
- Launch internal tools for sales, and service teams
- Open platform for 3rd parties (e.g., within B2B app store)

Digitization of product portfolio information

Integration of smart, connected products

Figure 19

4.2 The path towards an integrated B2B commerce platform

To implement an integrated e-commerce strategy as described in the previous chapter, machinery companies must manage several unique challenges: establish a fully customer-centric mindset, foster direct sales while digitally enabling sales partners, break up internal data silos, create consistent online and offline experiences, and manage an end-to-end digital thread across all channels including customer interaction points. This complexity is further compounded by varying regional customer demands and a high number of involved stakeholders. To orchestrate these challenges, we recommend using the a three-step approach (Figure 19), while simultaneously working on two additional challenges:

Digitization of product portfolio information

The implementation of digital sales applications is often associated with obstacles such as missing data or incompatible IT systems. One client, for example, intended to postpone the launch of an online product configurator for half a year because 75 percent of all product CAD drawings and prices were not fully digitized. Instead of waiting for the complete digitization of the entire product catalogue and the relaunch of its ERP system, the client took the recommendation to start the implementation with a limited, relevant range of products and a few pilot customers and then expand the configurator tool based on gained experience.

Integration of smart connected services

Fully scaling an integrated IIoT and e-commerce platform can be daunting, and it is often difficult to select the SBU or area of

focus with which to begin the implementation process. Consider the alternative of implementing initiatives along both of these processes simultaneously by forming a central product owner team responsible for synchronizing the initiative across lower-level functional owner teams, each responsible for different platform functions (e.g., application wiki, solution configurator, order management, IIoT asset management). The integration of e-commerce and IIoT should take place in phase two and continue through all consecutive phases (Figure 19), constantly adding new digital tools and smart services to speed up processes and increase customer satisfaction.

Key takeaways

The implementation of integrated B2B commerce strategies is associated with several customer-centric challenges including direct sales, sales partner enablement, data silos, and multichannel customer interactions.

To address these challenges, a three-step approach for digitalizing the customer journey suggests beginning with the most relevant customer touchpoints, followed by a gradual integration of connected physical assets into the customer platform, and finishing with the consolidation of smart services to transform the customer platform into a holistic business platform.

Challenges and roadblocks to realizing B2B commerce potential

Dimensions	Challenges and roadblocks machinery companies need to address to leverage full potential of B2B commerce					
Strategy	Creating a comprehensive, but tangible digital-sales strategy	Integration of B2B commerce with IoT strategy	Right allocations of project and resources			
Customer & channels	Lack of direct customer access and conflicts with dealer structures	Complex B2B buying centers with multiple stakeholders	Various markets, customer types, and demands	Integration of complex products and customizations	Designing hybrid journeys combining digital and human	Omni-channel sales ecosystem
Technology & operations	Integration with legacy systems (buyer and seller)	Data security-concerns	Right metrics and incentives to monitor results and drive digital sales efforts	Selection and integration of commerce platforms and technology partners		
Culture	"Culture eats strategy for breakfast" – Traditional sales mindset can block entire digital sales efforts					

Figure 20

4.3 B2B commerce roadblocks

Among those machinery companies already convinced of the significant upside potential of B2B commerce, many have still failed to meet expectations and often lose momentum after the pilot stage. Figure 20 illustrates four dimensions of challenges and roadblocks that must be addressed to avoid this industry trend.

Strategy: Create a comprehensive but focused B2B commerce strategy that leverages IIoT technologies

Many machinery companies have launched numerous isolated activities in different business units to address different parts of the customer journey. Furthermore, B2B commerce is often merely regarded as an IT project. Both approaches result in a too-narrow scope and thus limit potential outcomes. In order to obtain successful scalability, machinery companies need to develop a holistic digital transformation strategy that includes digital sales and IIoT strategies that still maintain and support the integrity of the overall corporate strategy.

Customer and channels: Design integrated, hybrid customer journeys across channels

Machinery buying processes take time and are usually highly customized and complex, with multiple stakeholders involved. For companies with multiple distributors and resellers, the complexity is increased. Machinery companies often lack in-depth customer knowledge, especially regarding insights into customers' operations. With little-to-no access to end customers, machinery company suppliers feel this shortcoming most

keenly. Consequently, suppliers and sellers miss opportunities to integrate customers into the value chain, connect and track machinery performances, and sell profitable IoT services.

Machinery companies need to develop effective customer integration methods that do not endanger existing relationships or sales revenues via distributors and resellers. Instead, they should strategically weave them into the digital transformation model to capture value-added advantages, such as savings achieved by process automation or revenue sharing models for new digital services.

Companies successful in this stakeholder integration strategy have designed hybrid customer journeys that reflect diverse channels and products as well as various types of customers and their respective demands. These hybrid customer journeys meet individual customer preferences at any touchpoint and can switch between human interactions, digitally enabled services, or fully automated self-service.

Technology and operations: Back up technology with organizational investments and process change

Legacy system architecture with disjointed subsystems can cause functional silos². For B2B commerce integration to succeed, ERP, CRM, cybersecurity, and IoT systems as well as an overall transformation of legacy organizational structures and processes must be interconnected³. It is also important to remember that these technology-focused programs still support a primarily customer-driven exercise within B2B commerce.

² – According to a study from IFS, 84 percent face a disconnection between these systems

³ – <https://www.zdnet.com/cdn.ampproject.org/c/www.zdnet.com/google-amp/article/the-tension-between-iiot-and-erp/>

Therefore, machinery companies must bring security, costs, speed, and convenience in balance with customer experience.

Culture: Transition to a new way of working in a culture of agility and innovation

Machinery companies reinventing their B2B commerce must also factor in the development of change management programs, as traditional sales approaches with “box-moving mentalities” are no longer appropriate. Traditional B2B companies also need to adjust their incentive systems in a way that makes B2B commerce sales more attractive to sales management and staff. Leaders must look to combine a clear, top-down vision with bottom-up enthusiasm to unlock commitment across the entire organization.

Key takeaways

Most machinery companies in B2B commerce have not yet realized the expectations associated with digitalization and integration initiatives.

The most common roadblocks can be found in four dimensions: strategy, channels, operations and technology, culture.

Mitigating actions include:

1. Creating a comprehensive yet focused B2B commerce strategy;
2. Designing integrated, hybrid customer journeys across channels;
3. Backing up technology with organizational and process change;
4. Transitioning to a new way of working along agility and innovation initiatives.

05 Structuring digital transformation for digital machinery

Roadmap for the digital machinery transformation – 12 imperatives that lead the way

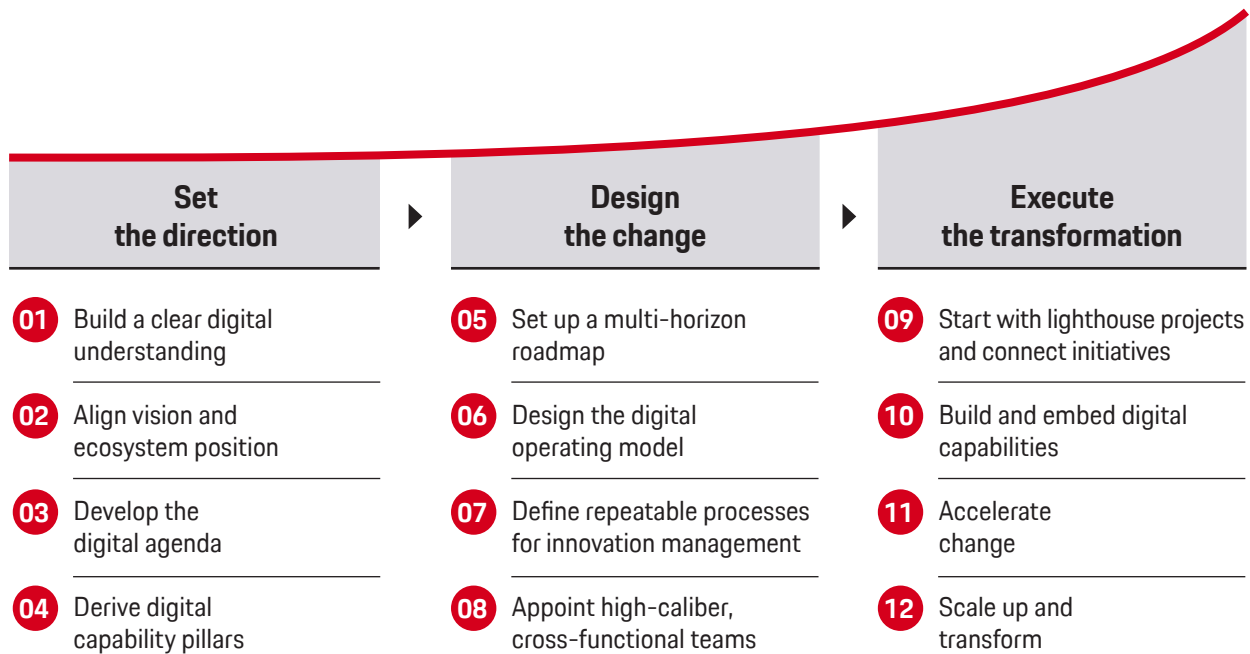


Figure 21

In the previous chapters, the digital opportunity space for machinery companies has highlighted the Industrial IoT and B2B commerce. Therefore, this chapter will outline a successful digital transformation journey. The following is a practical step-by-step guide on how to master the digital machinery transformation (Figure 21).

5.1 Set the direction

01 Build a clear digital understanding

The “why” question creates a sense of urgency and answers why digitalization matters to any given industry in general and any business in particular. It is important to acquire a clear understanding of any new disrupting digital technologies, changing customer demands, or increased competitive dynamics. Executives need to understand what organizational ambidexterity (e.g., existing vs. new business, efficiency vs. innovation) means to their business and which counterparts have to be balanced. These insights lay the foundation for defining strategic areas of action and tailoring the transformation plan. As a first step, capture macro digital trends and assess how these changes will impact the business. Although not exhaustive, the following list of strategic insights can serve as a roadmap to a thorough situational analysis.

- **Overall impact of digitalization** (e.g., value proposition, brand)
- **Future outlook** (e.g., self-learning algorithms, disruptive business models)
- **Customer insights** (e.g., digital touchpoints, self-service)
- **Evolution of products and services** (e.g., shifting profit pools to services, digital tools)
- **Changing operations and supply chains** (e.g., new technologies, faster cycle times)
- **New ecosystems** (e.g., new competitors, changing roles of suppliers)
- **New digital capabilities** (e.g., data science, user experience design)
- **Innovation culture and new ways of working** (e.g., design sprints, scrum)

There is no one-size-fits-all approach for gaining these insights. One creative idea is guided immersion trips to startup ecosystems such as Silicon Valley or Tel Aviv. This is an effective and interactive experience in which participants can see firsthand successful digitalization and change, gather relatable ideas, and gain inspiration from leading technology companies that have built cultures of innovation and established new ways of working.

Furthermore, machinery business leaders need to orient their strategy toward a completely new pace with respect to change and continual improvement. The exponential speed of digital developments that requires faster innovation cycles than ever before and the 10x thinking mentality of pure digital players reflects a total contrast to the 10 percent thinking approach of most traditional players in the industry (e.g., 10 percent increased customer satisfaction, 10 percent higher performing machines).

Leaders need to be open-minded and agile, with a purely digital approach to new technology applications, enhanced levels of customer service, platform initiatives, and the integration of innovative solutions on every organizational level.

Addressing the “why” questions will lead to a systematic understanding of how digitalization is impacting the current business model from end to end and that, as with any other industry, the biggest risk for machinery companies is doing nothing or failing to keep pace with industry leaders.

02 Align the vision and ecosystem position

Having gained a better understanding of digitalization as it relates to any particular business through the situational analysis exercise, the formulation of a clear vision initiates the digital transformation. A bold vision is very powerful in communicating the severity of going digital. In addition, it helps to align management and employee initiatives and sends a clear, cohesive signal to the market.

Jeff Immelt, GE’s former CEO, serves as a great example for conveying a vision in his address to a large audience of customers and analysts at the Minds + Machines summit in 2014: “If you went to bed last night as an industrial company, you’re going to wake up this morning as a software and analytics company. This change is happening in front of us. GE wants to be your partner.”


Figure 22 shares other far-reaching visions of selected digital champions. From the perspective of a machinery company, they might sound a bit too focused on improving the world, but they are simple to understand, highly distinctive, and have strong identification power.

Along with a bold, innovative, and encompassing vision, it is equally crucial to explore the future of the current ecosystem and align top management with a strategy that addresses expected changes and opportunities within the ecosystem. Figure 23 illustrates five different potential archetype models within a given ecosystem, and each requires a broadened shift in perspective from traditional operational strategies. Whereas most

companies view themselves as single industry players competing against comparable industry peers, any business in the digital economy can be a player within multiple industries, as part of a broader ecosystem, at any given time.

Far-reaching visions of selected digital champions

 ► “Provide access to the world’s information in one click”

 ► “Transportation as reliable as running water, everywhere, for everyone”


 ► “To be earth’s most customer-centric company, where customers can find and discover anything they might want to buy online”

Figure 22

The ecosystem of machinery players includes suppliers, competing OEMs, distributors, dealers, partners, customers, tech players, and startups. Digitalization tears down boundaries and entry barriers between formerly separate industry participants—the suppliers, OEMs, distributors, and partners. From an opportunistic perspective, it provides growth potential to incumbents, such as leapfrogging value chains (e.g., suppliers provide digital services directly to OEM customers), but also implies threats of disruption from purely digital players entering the B2B stage with platform-enabled business models (e.g., matchmaking platforms to broker production capacities).

03 Develop the digital agenda

A bold vision and a competitive positioning strategy do not necessarily guarantee success. Digital transformation requires planning that ensures effective and fast implementation. After determining why digitalization is important, it is necessary to determine what needs to be digitalized. What are the strategic areas of action? What are the most relevant use cases within these areas? Which functions are most affected? What are the key enablers that drive the digital program? What are the milestones for deployment?

Together with the outcome of the previous section, answers to the “what” questions create the digital agenda. A digital agenda is an overall navigation system for a company’s digital transformation, unifying strategic direction, ambition levels, enablers, and measures to achieve them—all condensed in a coherent roadmap for accelerated implementation (Figure 24).

Five different archetypes as a guideline for ecosystem positioning

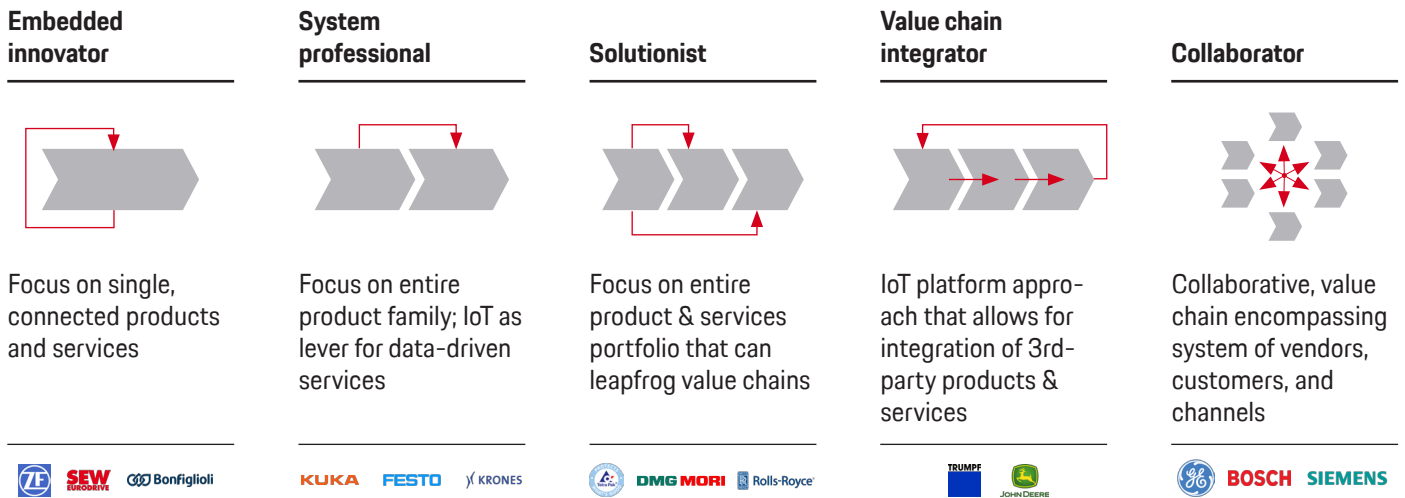


Figure 23

(Companies exemplary for archetypes)

The digital agenda serves as the overall navigation system for the digital transformation

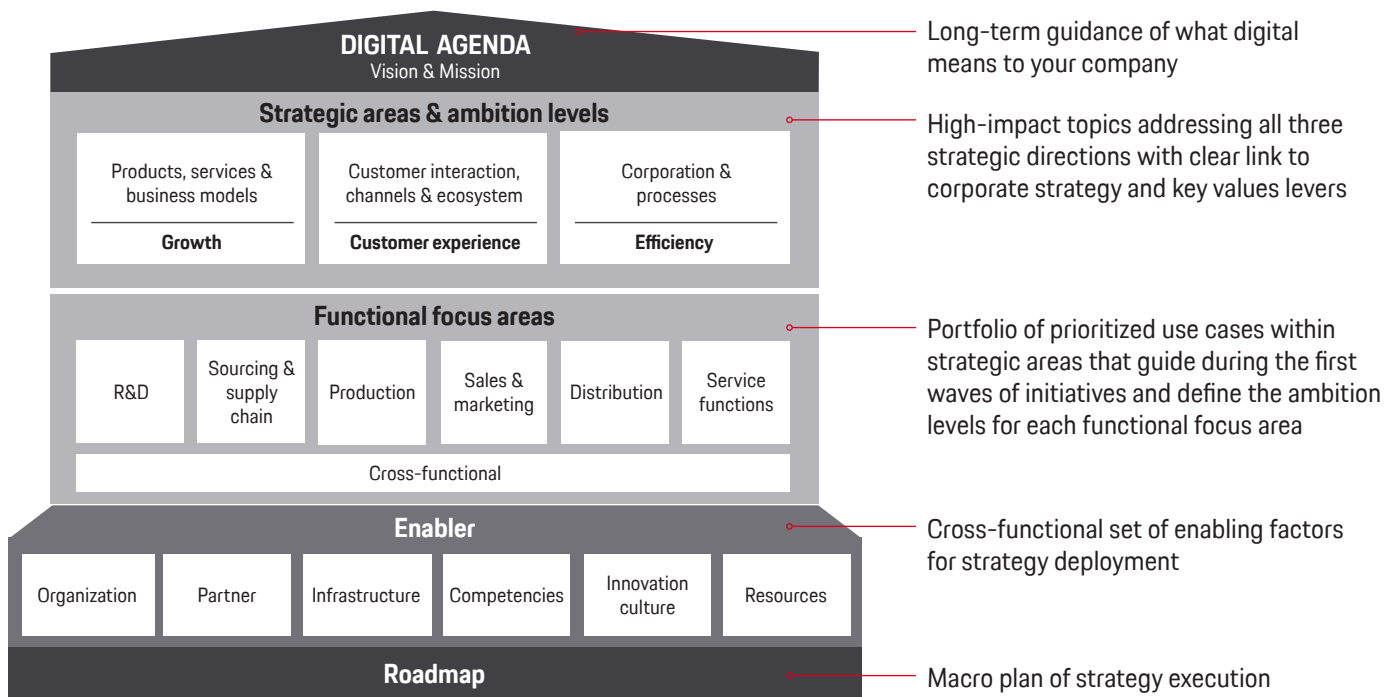


Figure 24

(Framework applicable at corporate, business unit or functional level)

The digital agenda should allow for course corrections and the ability to capture new opportunities along the journey. While every digital agenda is different, they generally include the following elements.

▶ **Digital vision**

A clear, ambitious statement that is well understood throughout the company and connects digitalization to sustainable profitable growth.

Example: "We are the world's most customer-centric provider of end-to-end packaging solutions that guarantee 99.99 percent equipment uptime."

▶ **Strategic areas**

A small set of high-impact topics tied to the corporate strategy

Examples: "Growth through outcome-based services." "Customer-facing platforms."

▶ **Prioritized use cases**

A set of preeminent use cases (including concrete ambition levels) of the highest priority regarding criticality, impact/feasibility, or function enabling.

Example: "Increase service contract volume by 50 percent with predictive maintenance as a service."

▶ **Enablers**

A derived and described set of must-have enabling factors that are critical to delivering desired results.

Examples: "Key internal competencies." "Establishment of digital competence center." "Innovation budget of three million euros for next year."

▶ **Roadmap**

A macro plan that aligns prioritized use cases with enablers to deploy the digital agenda and outlines key implementation measures and milestones.

04 Derive digital capability pillars

Once the digital agenda is created, the next step is to translate strategic areas into required digital capabilities, encompassing all dimensions of the business. Instead of deriving various isolated requirements with regard to people, processes, or technologies, build a small portfolio of integrated and cross-functional pillars that are tangible and self-explanatory. Figure 25 gives examples of such capabilities with specific regard to machinery companies. Defined digital capability pillars are important for two reasons: they guide the allocation of resources (budgets and people) and support the assessment of future digital initiatives.

Exemplary digital capability pillars for machinery companies






	 Smart services	 Connected machines	 Digital customer interactions	 Advanced analytics	 Connected workforce
Innovative customer solutions by adding smart digital services to products	Industrial IoT-based connected machines to enable remote access and smart services	End-to-end digitalization of customer journeys to improve satisfaction and increase sales	Advanced analytics and machine learning to turn data into insights and new business outcomes	Mobile tools and digital services to enable, empower, and augment workforces	
Strategic area #1	✓	✓		✓	
Strategic area #n			✓	✓	✓

Figure 25

5.2 Design the change

Equally important to setting the direction is the design of the mechanisms for its deployment. Consider the following chapter the bridge between digital strategy and scalable transformation.

05 Set up a multi-horizon roadmap

To ensure that early efforts create the necessary momentum, give careful consideration to the selection of initial projects and the resources needed to adequately support them. Over time, it becomes mandatory to maintain a portfolio of “use case bets,” with dependencies and interlinkages. To master orchestrating these challenges, set up a multi-horizon digital roadmap that aligns prioritized areas of action with business objectives, enablers, and resources from short-, mid- and long-term perspectives. Consider it a living plan that evolves over time through continual testing, learning, and adapting the digital agenda. Figure 26 offers an example of such a roadmap for a machinery business.

Setting up a multi-horizon roadmap should be done in two steps. First, define the dependent and independent dimensions. Use the y-axis to map the strategic areas and the x-axis to define enablers and resources. The second step requires the use of all gained knowledge to turn the company’s digital investments

into actions, focusing on those that will have the most impact at scale. To ensure this, consider these five key factors in your evaluation and prioritization: What are the customer pain points to be addressed? What will add the most value? What are the low-hanging fruits that create momentum? Where and how can the company occupy strategic control points? Which enablers lay the foundation for others?

06 Design the digital operating model

With the digital agenda and roadmap defined, the next step in the transformation is the design of a coherent digital operating model that serves as a blueprint for structures, digital governance, mechanisms, and the culture needed to execute the digital strategy at scale. Most companies are working with an out-of-sync operating model that does not reflect the requirements of today’s digital economy such as speed, agility, and self-empowerment. Below is a practical framework for the design of a sustainable digital operating model (Figure 27).

The crucial first step in designing a digital operating model is translating the digital strategy into a selection of simple, concise, and self-explanatory design principles. This selection—typically eight to ten principles—provides the criteria for testing and adjusting the digital operating model over time, bringing

A multi-horizon digital transformation roadmap

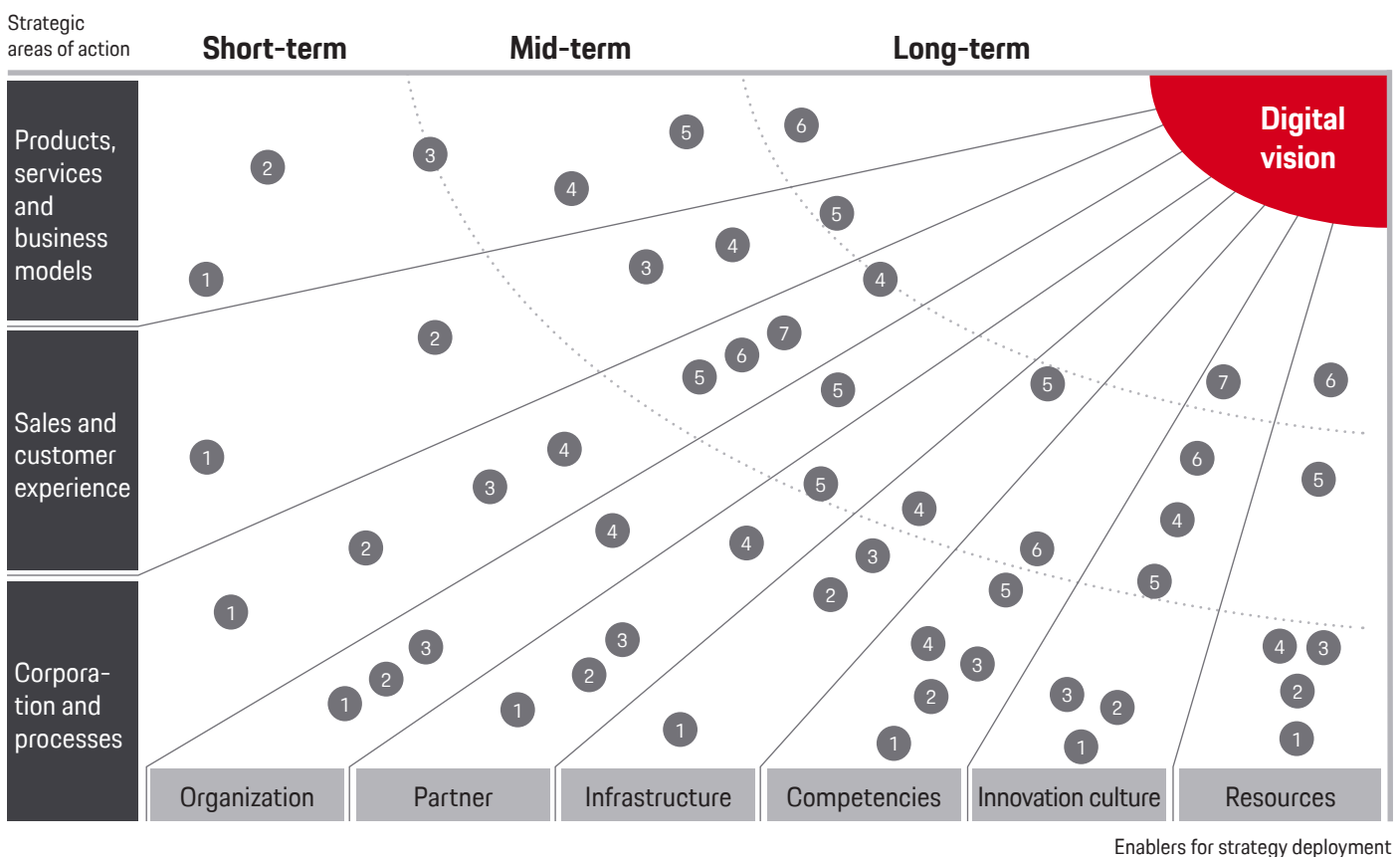


Figure 26

objectivity to what is frequently a politically infused process. Based on these design principles, the operating model takes shape through decisions in four key areas:

- ▶ **Digital organization design** defines roles, business lines, and coordinating mechanisms to drive digital transformation while leveraging scale and expertise. Key pillars include digital leadership, the chief transformation office, centers of excellence, and business vs. product ownership.
- ▶ **Digital governance** defines the steering mechanism of the digital transformation that yields high-quality decisions on strategic priorities, resource allocation, and business performance management. Key pillars include performance management (e.g., via objectives and key results, or OKRs), innovation management (e.g., innovation funnel concept), and risk management (e.g., adopt-or-kill principles).
- ▶ **New ways of working** define structures, mechanisms, and cultural norms to accelerate cross-functional digital innovation and go-to-market. Key pillars include digital product management, collaboration workflows, and innovation culture.

- ▶ **Capabilities and partners** describe the required digital competencies and define the mechanisms to integrate people, partners, technology, vendors, and startups to fill the gaps. Key pillars include digital competencies, talent and skill management, and ecosystem building.

The last step is to derive and define the foundation, encompassing standards and guidelines (e.g., predefined requirements for agile project teams) as well as infrastructure and technology. A new approach for incumbents is the platform strategy—a crucial shift from using individual technologies, operations capabilities, and systems in a piecemeal manner to applying central platforms that leverage experience and scale to achieve more encompassing and pervasive influence throughout the business. This applies to technologies or systems (e.g., central customer platform) as well as digital skills (e.g., predictive models) and accelerates internal digital transformation, thereby enabling new external digital business opportunities. Companies in the digital beginner stage (see imperative no. 12 “Scale up and transform”) should especially look to establish centers of excellence for core capabilities such as the IoT platform or advanced analytics skills.

The digital operating model framework

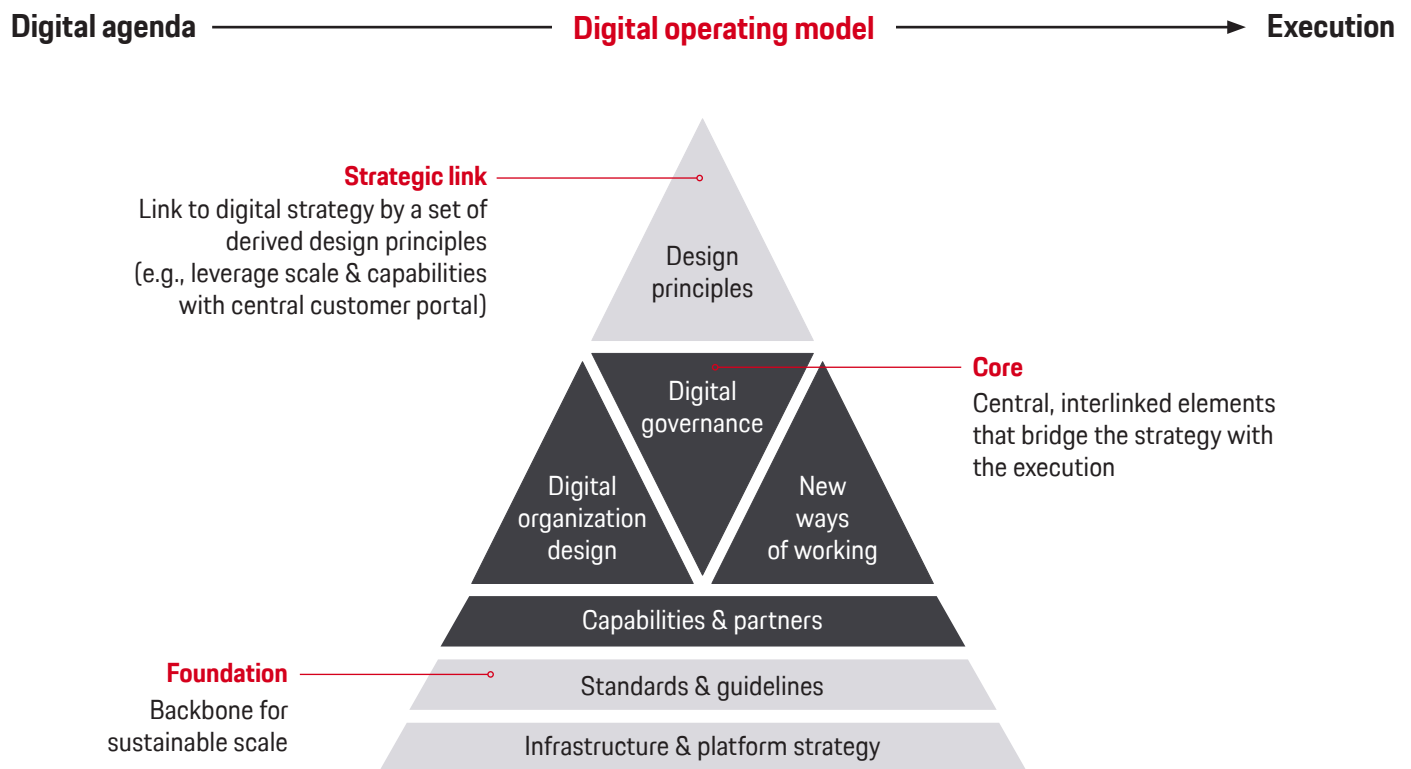


Figure 27

07 Define repeatable processes for digital innovation mgmt.

With the definition of an overarching digital operating model, the focus should now shift to defining repeatable processes and tools that ensure a structured innovation management, while maintaining the necessary agility and effectiveness. Digital innovation management can be divided into four building blocks:

- **Idea sourcing and ideation**
- **Stage-gate innovation funnel**
- **Ownership and responsibilities**
- **Tools and workflows for test-and-learn**

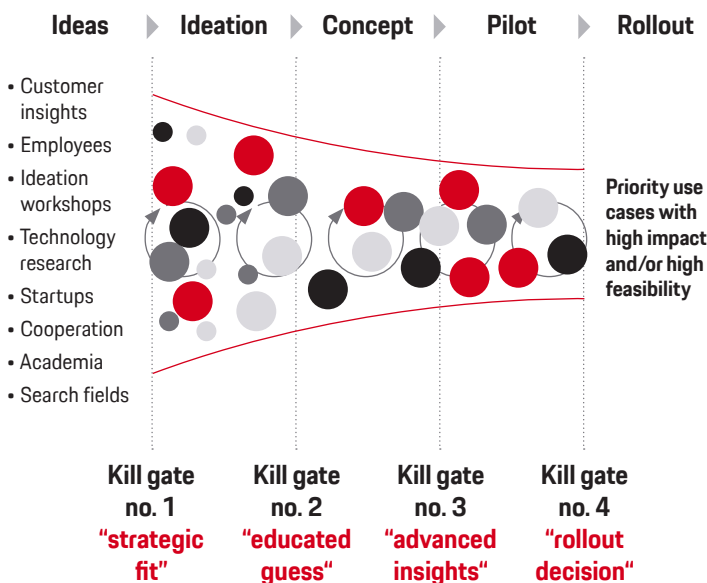
As a first step, align with stakeholders and partners on how to maintain a continuous flow of high-potential ideas that feed the portfolio pipeline. Ideas should be generated by leveraging a wide range of inputs, incorporating the newest digital trends on technologies, products, and business models as well as a diverse set of perspectives on internal and external customers,

problems, and opportunities. Second, define a stage-gate process through which to funnel ideas, including an assessment tool to evaluate and filter ideas against a robust set of criteria. Figure 28 illustrates a funnel example with four “kill gates” and a proven two-dimensional assessment matrix. Both dimensions—feasibility and business impact—are backed with a set of detailed sub-criteria. For example, benefit can be measured with direct monetization potential, ecosystem potential, data potential, or customer experience.

Together with the funnel and gateway mechanism, the ownership and decision rights for the evaluation processes need to be aligned. Lastly, employ a test-and-learn approach by providing standardized tools and workflows. For example, design sprints help to spark innovation, encourage user-centered thinking, align the team under a shared vision, and achieve product launches much faster in an agile way of working.

Innovation funnel and assessment matrix for portfolio planning

Innovation funnel along four “kill gates”



Assessment matrix for planning and evaluation

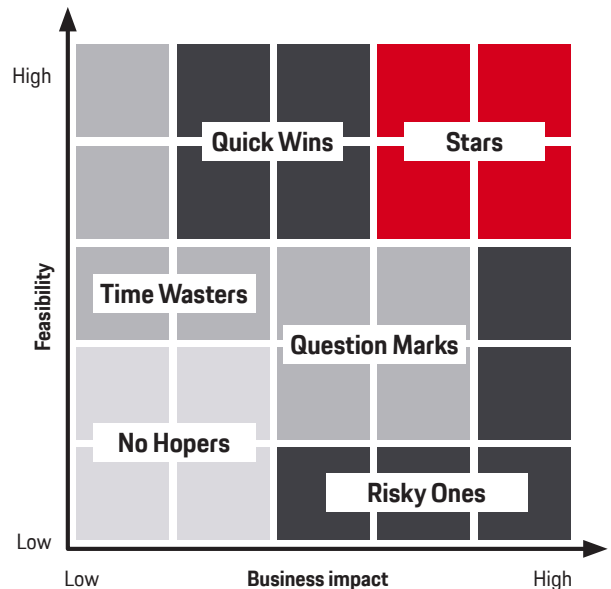


Figure 28

08 Appoint high-caliber, cross-functional teams

The importance of high-caliber, cross-functional teams cannot be overstated. They are key to any successful digital transformation. Companies need to establish these teams together with agile project structures and new ways of working to drive digital transformation (see also imperative no. 6 “Design the digital operating model”).

First, start with a small, high-caliber launch team to jumpstart the digital transformation. This team, often headed by the Chief Digital Officer (CDO), is an important catalyst for digital transformation and drives lighthouse projects by ensuring relevant technologies and skills are in place, monitoring progress against targets, and coordinating initiatives across the organization. Key recruits of a launch team should reflect the required capabilities (derived from imperative no. 4 “Identify digital capability pillars”) and can include the following members:

- **Digital product managers**
- **IoT platform experts**
- **Data scientists**
- **Multichannel specialists**
- **Scrum masters**
- **Software engineers**

The competitive market for digital talent makes finding high-caliber candidates a critical challenge. One way to meet this challenge is to appoint a well-known CDO with an established network that serves as an anchor hire. A high-caliber launch team is only one key component for going digital—albeit a critical one—that can help overcome the gap between first digital initiatives and transformation to scale.

5.3 Execute the transformation

With a fully designed transformation program, the next step is to switch over from planning to deploying digitalization to scale.

09 Start with lighthouse projects and connect the initiatives

Executing digital transformation depends on aspired goals, existing (infra)structures, resources, and capabilities of the organization. In practice, consider a three-step deployment process, following the core transformation approach described below, which we call “Learn. Make. Connect and Scale.”:

- ▶ **Share lighthouse** best practices across the organization, evaluate and sharpen use cases, and optimize top fields of action. If necessary, tear down any existent barriers to foster collaboration.

- ▶ **Translate the lighthouses** into pilots by connecting and rolling them out across the broader organization and leveraging their impact to scale.

Two alternative approaches have also proven suitable for scaling up pilots. The following paragraph describes the two approaches with respect to production pilots, but they can also be applied to other types of lighthouse projects such as new products or digital services.

One approach is the “rollout of best practices.” Companies define one leading plant per segment, share best practices between them, and optimize the most promising fields of action. Afterwards, these high-potential use cases are rolled out to all plants.

The second approach is the “rollout segment by segment.” Plants are divided into segments with individual leading plants and one overall strategic plant; this serves as a starting point to identify top fields of action and evaluate potentials. Initially, all top fields of action will be implemented and optimized at the strategic plant and rolled out to other plants in the corresponding segment. Subsequently, the next segment will follow with the same implementation sequence.

10 Build and embed digital capabilities

Parallel to implementing digital initiatives, it is crucial to focus on digital capability building. This includes technologies, tools and methods, and, more importantly, skills and digital talents. Without a digitally enabled (and digitally extended) workforce, companies will struggle to continuously leverage the latest technology advancements—from IoT, robots, and advanced analytics to artificial intelligence and virtual reality.

To build and embed a strong set of digital capabilities, you must first answer three important questions:

- ▶ **Which** skills, technologies, and other capabilities are generally required based on the defined digital capability pillars (imperative no. 4, chapter 5.1). Which are specifically required to derive digital job profiles for the waves of initiative in the near future?

- ▶ **Where** should the required capabilities be sourced—fully internally (e.g., via hidden “digital champions” in business units or supporting functions), fully externally (e.g., via startups), or in some form of hybrid (e.g., mixed teams of internal and external experts)? External examples include:

- Startups, tech vendors, and digital platform companies (for technology sourcing)

- Other corporations, headhunters, academia, and hackathons (for talent acquisition)
- Venture capital funds, startup innovation hubs, crowdsourcing, or data-driven customer insights (for innovation sourcing)
- Third-party field service operators and value-added resellers (for sales and service fulfillment sourcing)

► **How** should these capabilities be embedded (e.g., recruit, develop, and retain digital talents; integrate startups technologies into own offerings)? Keep in mind, a digital strategy is only as strong as the people who execute it.

Digital capability sourcing map

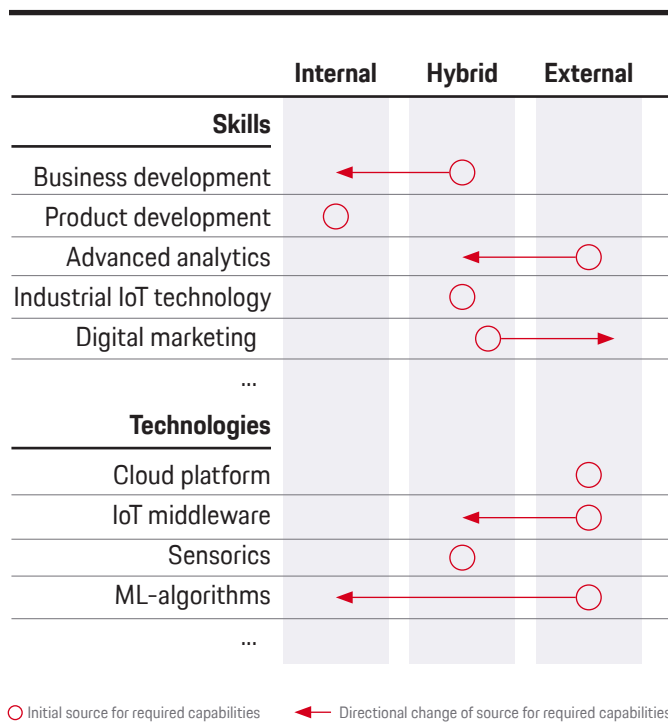


Figure 29

Figure 29 illustrates an approach to elaborate and map the digital capability building strategy to each of the defined digital capability pillars (for example, “Smart services”). Capability building includes sourcing and the digital operating model which brings these newly established capabilities into action (see imperative no. 6, chapter 5.2). One paradigm for the deployment of the digital operating model, as learned from recent digital transformation mandates, is the substitution of existing, hierarchical, and silo’d organization structures for modern structures with agile project management, autonomous teams, and customer-centric, innovative cultures. Without this foundation, both skills and digital initiatives cannot develop sustainably or contribute to the success of the digital transformation. Transformation is infinite in every application, and the same applies

for building capabilities. Some machinery companies, therefore, set up in-house academies or competence centers to support learning on an on-going basis. Alternatively, companies can also create knowledge platforms that enable sustainable knowledge sharing, invest in startups, or hire external experts to update learning. Regardless of the method, the ultimate goal of continuous learning is to establish digital change as a routine.

Counterparts to be balanced for successful digital machinery transformation

Hardware vs. Software

Should we invest 10 million for 10% machinery performance improvements (hardware) or for generating 100% new opportunities (software)?

Core vs. New business

How can we strengthen our core business and generate new business at the same time (ambidexterity)?

Integrate vs. Separate

Should we develop new business within the organization or externally?

Tradition vs. Innovation

How can we maintain our core values and innovate beyond?

Competition vs. Cooperation

How can we differentiate ourselves from the competition and join forces where needed?

Control vs. Agility

How can we maintain (process) control and generate required agility for digital?

Figure 30

11 Accelerate change

Technological progress may well play a dominant role in the digital machinery playbook. Three additional but often neglected principles will impact the digital machinery future to an even greater extent—the balancing of business counterparts, digital leadership, and continuous communication. Close attention to these elements accelerates change.

Becoming a digital leader is not an easy game for machinery players, as they have to balance various business counterparts at the same time. Below are six key initiatives in the machinery

industry that have to be carefully balanced to drive change (Figure 30). Success is achieved by those who are able to create, manage, and reunite these counterparts.

The second change accelerator is digital leadership. Non-negotiable components include:

- ▶ **Digital transformation** must be driven by the CEO and his/her C-level colleagues; transformation will fail without top-management commitment.
- ▶ **Digital leaders** must have the power to bridge functional silos.
- ▶ **Digital leaders** must set the pace and constantly facilitate roadblock mitigation measures.
- ▶ **Digital leaders** must foster data-driven decisions.
- ▶ **Digital leaders** must provide core principles that the entire organization will adhere to and believe in, while leaving room for autonomous team decisions.
- ▶ **Digital leaders** must provide just-in-time feedback.
- ▶ **Digital leaders** must be risk-orientated and leave their comfort zones.

The third driver of change is communication. Communication plays a dominant role throughout the entire digital transformation journey—from communicating an initial sense of urgency and, once the digital agenda is formulated, the vision, strategy, and opportunities ahead to communicating successes and failures in the pilot phase. After the pilot phase, it is crucial to share successes (lighthouse cases) and significant progress; this generates the highest impetus to recruit not only those individuals most directly involved but also others throughout the organization that have not yet had any connection to digitalization. Communication should be a multichannel approach beyond traditional management meetings and newsletters. Digital communication platforms and collaboration tools such as “slack” connect relevant parties instantaneously, eliminating unnecessary middlemen and resolving issues or facilitating discussions on new ideas faster and more effectively.

12 Scale up and transform

By successfully mastering imperatives 1 to 11, machinery companies can achieve the following:

- An established, long-term digital vision
- A clearly, defined digital strategy and concrete ambition levels
- Established lighthouse cases, partly rolled out to several plants, divisions, or regions
- Unique digital initiatives for every division and functional area
- All initiatives across the organization fully aligned through the digital transformation office
- Core digital capabilities and development of new digital products driven by centers of excellence
- Digital transformation needs embraced by majority of management and staff
- First startup collaboration experiences

Now the transition from a “digital transformer” to “digital (out)performer” can take off. As illustrated by Figure 31, the fundamental characteristic of a digital (out)performer is that digitalization has become integral and is ingrained in every business or functional unit of the organization.

As such, digitalization is now a matter of course and no longer a necessary evil. Diverse digital use cases are up and running and positively impact almost every unit, either in terms of productivity gains, new revenue streams, or newly created customer experiences. Product ownership of mature digital topics have migrated from centers of excellence into business functions. The role of the digital transformation office has switched to digital topics in the nascent stage, where capabilities in business units do not exist.

What should machinery companies do to accomplish the migration from a digital transformer to a digital (out)performer? Although the answer depends on individual ambition levels, allocated budgets, and actual transformation progress and speed, there are four key components for scaling up digital business.

Evolutionary path of digital organizations

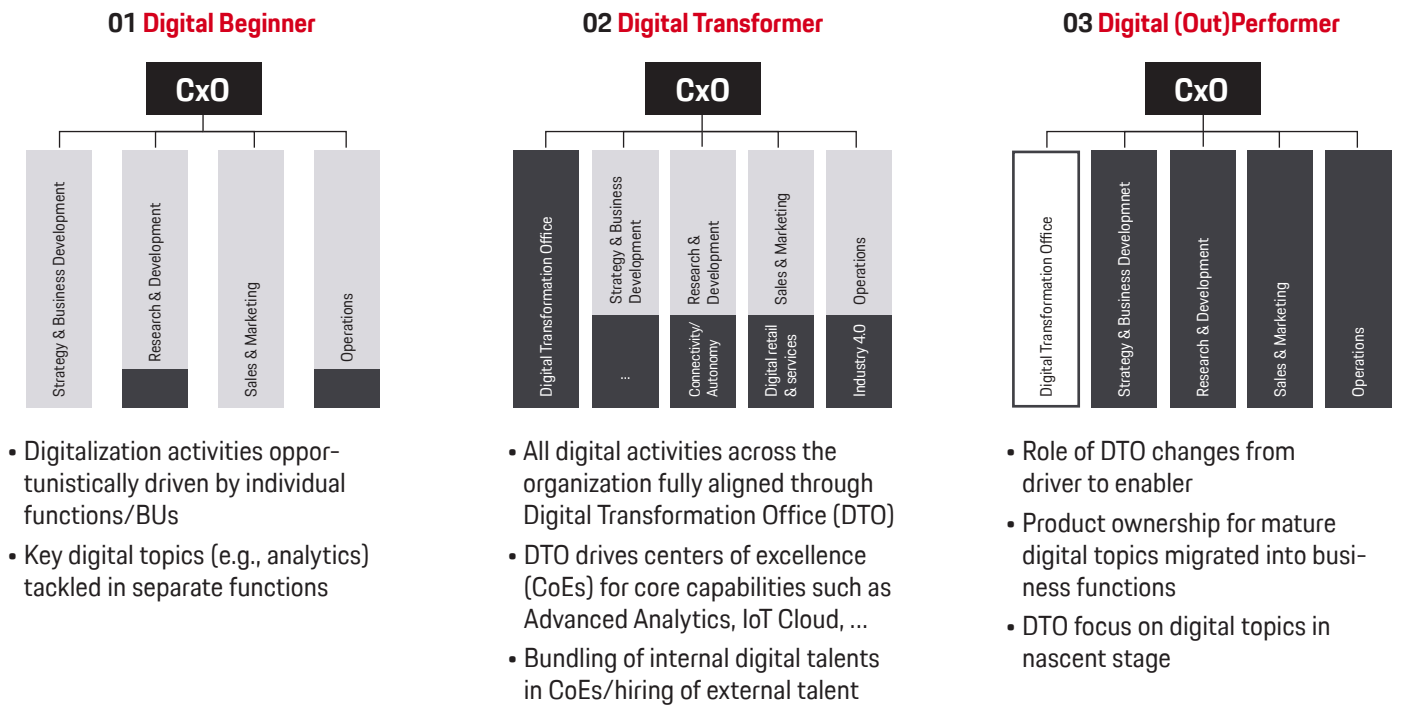


Figure 31

■ Digital activities/initiatives

Continuous improvements

As in any lean transformation, continuous improvements are a fundamental driver for sustainable digital transformation journeys, although at a much faster pace. In any traditional industry, incumbent companies that are continuously adopting and improving strategy, use cases, operating models, skill sets, innovation management, and ecosystem building can improve performance KPIs four to five times more successfully and sustainably. Porsche Consulting has experienced these higher success rates through continuous improvements in lean transformation client engagements over the last twenty years, and now in digital transformation project settings.

Adoption of operating model

The digital operating model as described in chapter 5.2 is an adjustable framework. All four key elements of the operating model require adaptations over time as priorities shift, digital maturity advances, or customer demands change. The digital organization design, for example, may evolve as illustrated in the above Figure 31. The scope of new ways of working, in terms of collaboration workflows or applied tools, may be broadened due to higher involvement of units, regions, and functions. Digital governance structures and performance KPIs need to be changed due to adopted business models. Ideally, digital transformation KPIs are wired to individual incentive schemes, preferably implemented C-levels, and for second- and third-level management.

Constantly innovate IT infrastructures

Only a digital IT operating model that integrates core and digital IT infrastructures can unlock the potentials across the entire organization. Regardless of the design of the mechanisms or the rollout plan, the overarching goal is to constantly optimize the core infrastructure with new technologies and minimize the divide between digital and conventional IT groups. Mechanisms and stakeholders should ensure that integrated teams are supporting common strategic objectives and investments in systems, processes, and talents to drive future success.

Sustain pace of change “The only constant is change.” This well-known saying could not be more apt in describing digital transformations. Exponential developments in technologies, competitor dynamics, and customer demands require constant change and correlated communication measures.

Following this playbook of twelve imperatives will be challenging. But it will also facilitate and significantly accelerate the digital transformation journey, in particular Industrial IoT and B2B commerce adoption.

Are you ready for your next industrial chapter?

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