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Thomas Friedli
Philipp Osterrieder
Moritz Classen *Editors*

Managing Industrial Services

From Basics to the Emergence of Smart and Remote Services

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Thomas Friedli • Philipp Osterrieder •
Moritz Classen
Editors

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Editors
Thomas Friedli
Institute of Technology Management
University of St.Gallen
St.Gallen, Switzerland

Philipp Osterrieder
Institute of Technology Management
University of St.Gallen
St.Gallen, Switzerland

Moritz Classen
Institute of Technology Management
University of St.Gallen
St.Gallen, Switzerland

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Foreword

Digital technologies create compelling opportunities for industrial companies not only in manufacturing but also with regard to industrial services. Traditionally, industrial companies provided after-sales services in the form of maintenance services for their equipment, sales of corresponding spare parts, software upgrades, etc. The Internet (of Things) now opened new dimensions for services provided by industrial companies. It allows hardware providers, for instance, to remotely access their equipment at the customer site. This enables them to diagnose the equipment and suggest preventive maintenance services. It also permits the company to better understand the utilization of its equipment, root causes for failures, parts that are subject to wear, etc., and, based on this, to draw conclusions for further product development. In recent years, the number of all kinds of sensors in industrial equipment has significantly increased, allowing customers and equipment manufacturers to gather an enormous amount of data that can be further analyzed by either party to derive meaningful insights. All of the possibilities mentioned above are often summarized as "smart and remote industrial services." Such smart digital services permit OEMs to expand their hardware and software revenue with an increasing amount of smart services and even to reconsider their business model. Some companies experiment with new approaches that enable them to overcome the high initial investments by customers and to expand and migrate to a more recurring revenue model (oftentimes referred to as "X-as-a-service"). Others consider smart digital services as an expansion of their offering to customers and leverage their know-how of production processes of customers via complementary smart services.

In light of all these digital possibilities, it is of crucial importance that industrial companies consciously design or redesign their business strategy and, in particular, their service strategy. The book at hand provides an excellent framework to approach this task. It does not only deliver ideas for compelling service strategies but also addresses corresponding organizational questions in transitioning to smart services. This has not only an internal aspect; the digital world of tomorrow frequently necessitates intensive collaboration in business ecosystems. Innovation often goes beyond product or process innovation. A key question is how to best position, price, and sell smart remote services. This book offers interesting cues on how to market

intangible products. The digital setup of an industrial company providing physical and smart services is another crucial topic to be addressed by industrial companies. The book at hand includes, furthermore, practical examples of industrial companies that successfully managed to introduce smart and remote digital services.

Swissmem Hans Hess
Zürich, Switzerland

Contents

About the Editors

Thomas Friedli is a professor of production management at the University of St.Gallen in Switzerland. His main research interests are in the field of managing operational excellence, global production management, and management of industrial services. He is a lecturer in the (E)MBA programs in St.Gallen, Fribourg, and Salzburg. He spent several weeks as an adjunct associate professor at Purdue University in West Lafayette, USA. Professor Friedli leads a team of 15 researchers who develop new management solutions for manufacturing companies in today's business landscape. He is also the editor, author, or coauthor of 14 books and various articles. Among his books is *Strategic Management of Global Manufacturing Networks* (2014), *Leading Operational Excellence in the Pharmaceutical Industry* (2013), *Wettbewerbsfähigkeit der Produktion an Hochlohnstandorten* (2012), and *Industrie als Dienstleister* (1997).

Philipp Osterrieder holds a degree in mechanical engineering from the Technical University of Munich, Germany, and a Ph.D. in management from the University of St.Gallen, Switzerland. Prior to joining Professor Friedli's team, he gained professional experience at several positions within the automotive industry and in a consulting company. Dr. Osterrieder was part of the competence center *Smart Manufacturing and Services* at the Division of Production Management, led by Thomas Friedli. His main field of research concerns the organizational integration of smart service activities at manufacturing companies.

Moritz Classen graduated in industrial engineering and management at the Karlsruhe Institute of Technology, Germany. He gained professional experience within the automotive and power generation industry. Moritz Classen is part of the competence center *Smart Manufacturing and Services* at Professor Friedli's Division of Production Management at the University of St.Gallen. He pursues a Ph.D. in management with a focus on industrial service strategy, marketing, and sales.

List of Abbreviations

B2B	Business-to-business
BPM	Business process modeling
CEO	Chief executive officer
cf.	Confer
CRM	Customer relationship management
e.g.	exempli gratia (for example)
EBIT	Earnings before interest and taxes
ERP	Enterprise resource planning
et al.	et alia
etc.	et cetera
GUI	Graphical user interface
i.e.	id est (that is)
IHIP	Intangible, heterogeneous, inseparable, perishable
IIoT	Industrial Internet of Things
IoT	Internet of Things
IT	Information technology
ITEM-HSG	Institute of Technology Management of the University of St.Gallen
KPI	Key performance indicator
MVS	Minimum viable service
NPS	Net promoter score
OEE	Overall equipment effectiveness
OEM	Original equipment manufacturer
PAT	Performance Advisor Technology
RPO	Remaining performance obligation
SaaS	Software-as-a-service
SSU	Sales and service unit
USP	Unique selling point

List of Figures

Chapter 6

Chapter 9

Chapter 12

Chapter 13

Chapter 14

Chapter 15

Chapter 16

Chapter 17

List of Tables

Part I

Theoretical Considerations

Introduction to Managing Industrial Services

Thomas Friedli and Philipp Osterrieder

Wars may be fought with weapons, but they are won by men.
—General George S. Patton

1 A Brief Review on Our Industrial Service Research

When we published our book entitled *Fit for Service – Industrial Companies as Service Providers* back in 2004 (Schuh, Friedli, & Gebauer, 2004), we believed that this would be our ultimate legacy to practitioners as well as to the scientific community in the field of servitization. This book had been the culmination of almost 10 years of research at the Institute of Technology Management at the University of St.Gallen and included findings and conclusions from dozens of applied projects. Our journey started in 1996 when we moved our research away from always having the product at the center of attention and started to think in what was back then called "performance systems," a term coined by our marketing colleague at the University, Prof. Dr. Christian Belz. We even published a first book that originated from a doctoral course at the university taught by this very Christian Belz and Günther Schuh on our side (Belz, Schuh, Groos, & Reinecke, 1997). This perspective still had the product in the center but intended to pay more attention to everything else that added value to the customers. As not only research but also practice was almost entirely focused on the product and product technologies, there was no real management of industrial services. Services were provided when the companies had to do it, like in the cases of putting a product into

T. Friedli (✉) · P. Osterrieder
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: thomas.friedli@unisg.ch; philipp.osterrieder@gmx.net

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operations or providing repair in case of breakdowns, etc. Accordingly, services had the image of being rather a burden than a potential competitive advantage. There was no transparency about either the costs or the benefits of services. We wanted to change this, and looking back, we were quite successful. We dealt with "Performance Systems in the Machine Tools Industry" (1996–1997), followed by a project about "Controlling Systems for Services" (1998–1999). One of the outcomes of this project was that the whole innovation process for services was quite poor in all the companies we worked with. Therefore, we launched the next project, "Service Development and Design" (1999–2001). Already then, we identified one of the key challenges in service management: commercialization. This gave way to our next project, "Commercialization of Industrial Services" (2001–2002), and was directly followed by our big integrative project entitled "Fit for Service" (2002–2003). The very aim of this project had been to summarize our results into one integrated framework, and our *Fit for Service* book became the documentation. Since then, we have worked with dozens of other companies in this field and started to discuss our research under an excellence umbrella, coining the term "Service Excellence." More and more technology became involved in our projects, especially since Industry 4.0 turned into a focus program in Germany, and others looked closer into new opportunities arising with connected products and the Internet of Things (IoT) or of Everything. The entire landscape changed again. Our research started to focus on smart and remote services, including new business models built on them. What did not change were the cultural and structural challenges as well as a lot of other topics to be considered when having to develop the service business from an overall company perspective. Therefore, we came to the conclusion that it was time to write another book—a more comprehensive book—which would be the new standard for industrial service management, again making a contribution to research and practice true to our slogan at the University of St.Gallen: "From Insight to Impact." We still believe in books as a medium to transfer our research findings. Writing books has obviously lost its importance at some universities because to publish results in renowned journals became much more important for the ratings of leading universities and the reputations of respective professors. However, to deal with the inherent complexity of today's practical challenges, there are just not enough pages available in a journal publication. If we want to cover a topic from an overall system perspective, it is still the book that provides us with this possibility.

This book covers a broad spectrum of topics all aimed at professionalizing the industrial services business at manufacturing companies. It provides a plethora of methods, tools, and approaches on how to do this successfully. However, it does not suggest that every company has to strive to grow the service business. The very first analysis is to answer the question about the "what" (i.e., the contribution the service business has to make for the overall competitiveness of the respective company). Without this clarification, there will be just too many potential conflicts further away. Additionally, returning to the quote at the beginning of this introduction from General George S. Patton, ultimately, it is people who make a company successful. Therefore, leadership and engagement will become decisive on how that is accomplished. In the following, we briefly describe the structure of the book.

2 Structure of the Book

After this short introduction, we continue Part I of this book with the - Chapter "Servitization of Manufacturing Companies," shedding some light on the reasons for the continued servitization in industrial companies and highlighting some challenges along the way, such as the service and digital paradox. Additionally, we describe the evolution of smart services and provide a better understanding of the characteristics of these new kinds of services in comparison to traditional physical services. The Chapter "Fundamentals of Industrial Service Management" provides a summary of findings from our long track record in researching the field of industrial service management, focusing on fundamentals that still held true. In the Chapter "Service Strategy," we explain the importance of a service strategy and how to define it, also describing some distinctive general service strategies. In the Chapter "Organizational Structure," we examine the organizational structure of the service organization. The challenges became bigger with the emergence of smart services, as with them came a need for new skills to include in the considerations. In this chapter, we also provide some data-backed insights. Chapter "Service Innovation," deals with service innovation, building on our earlier work but integrating the latest research findings to a promising approach to service innovation. Chapter "Service Sales," further develops our thinking about the commercialization of services, including the characteristics of smart services and integrating findings from business model innovation research. Chapter "Service Operations," adds a perspective on service operations management. After an initial focus on concentrating on the service as a product and rather the effectivity, the leading companies started to think about efficiency too. What we see today is an industrialization of the service business drawing from lessons from process optimization and lean management. In the Chapter "Customer Relationship Management and the Value Network," we focus on the customer and how to manage the customer interface. This includes a transformation from a product-centric to a truly customer-centric approach. The Chapter "Outlook and Summary of Managing Industrial Services" provides a summary and outlook before we shift to Part II of the book focusing on the current status in practice. Leading companies like John Deere or Schindler describe their approaches, providing a comprehensive overview of state of the art in practice.

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Servitization of Manufacturing Companies

Philipp Osterrieder

Preparedness is the key to success and victory.
—General Douglas MacArthur

Key Takeaways

- Most manufacturing companies find themselves in some sort of transition phase toward providing more services today; this transition is known as servitization.
- We differentiate between physical and smart services, both imposing a variety of challenges for the manufacturers' organization.
- The emergence of digital technologies enables companies to offer new kinds of services based on hardware, software, and data.
- However, manufacturers should be aware of the pitfalls of undirected servitization and digitalization efforts described as the service and digital paradox.

The servitization of manufacturing companies means that these organizations start to offer services as an added value to the existing product portfolio and generate revenue streams from these services. To be able to do so, companies create new teams, hire new employees, build new partnerships, leverage new capabilities, and ultimately evolve into handling both the product and the service business. Servitization, therefore, describes the transition of a manufacturing company from a pure product provider to a state of delivering services next to products, or even of providing complete solutions.

P. Osterrieder (✉)
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: philipp.osterrieder@gmx.net

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But why do companies servitize? It may seem odd for a manufacturer that excelled in providing high-quality goods over the past 10, 20, or 50 years to invest in the creation of a new customer-centric service business, having to complement his usually engineering-dominated culture by a stronger customer orientation.

Some companies grew their service business naturally as customers just demanded the delivery of services. Many organizations, however, deliberately embraced the challenge as services promise multiple benefits among others, customer loyalty, and more stable returns with higher margins.

The phenomenon of manufacturing companies offering services in addition to their products is nothing new. More than 30 years ago, Vandermerwe and Rada (1988) coined the term servitization, and manufacturing companies provided services long before that. Yet, living in a service society, such offers gained increasing importance in the past 20 years for the continuous development and growth of many organizations.

We will delineate the servitization journey along with an explanatory example in the following. This culminates into the description of two paradoxes many companies encounter on their journey: the service and digital paradox. Finally, we offer a distinction between the two general types of services discussed in the book at hand.

1 The Servitization Journey

Every journey begins with a starting point. This can be a situation in which a manufacturer focusses on the product and product innovation only. For years, this manufacturer made a good business based on his technologically superior product.

Imagine a manufacturer of machine tools. Starting with a good idea, a filed patent, the knowledge about customer demands, and the ability to transform these into a competitive product, the company grows based on the success of the engineering department. Consequently, it improves the current generation and broadens the scope of its business in the following years. With a focus on technological advancements and the devotion to deliver high-quality products, the company finds itself in the first stage displayed in Fig. 1.

Now, there exist generally three drivers for change our imaginary machine tool manufacturer may encounter. First, the CEO anticipates the possibility of, for

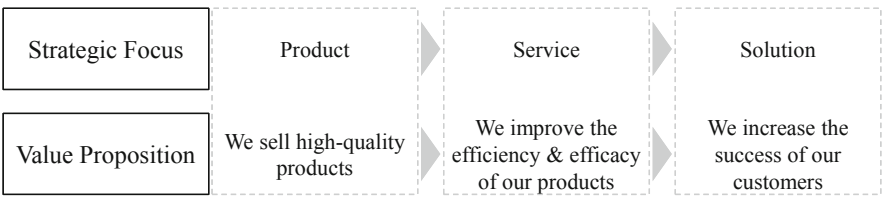

Fig. 1 The servitization journey. Own illustration

instance, increasing customer satisfaction, or to stabilize fluctuating returns due to cyclic demand patterns with services. Second, customers increasingly request basic services, such as training or maintenance operations. Third, the CEO is aware of the need to offer additional services but decides to concentrate on the product business and partners with a third party providing the required services.

As the third scenario implies that the focal company does not follow the servitization journey, we elaborate only on the first two options.

1. Strategic Initiative
   The CEO may have seen the potential of services for their business at other companies, but anyway, believes in the competitive advantage of providing services. With the impetus to improve the efficiency and efficacy of the companies' products, the CEO guides the organization into a transformational change.

   With the continuous technological advancements and the accompanying increase in the products' complexity, the company may opt to provide training services. We have seen in the last decades that not only the original equipment manufacturers (OEM) but also their customers streamline their organization. With this development, the OEM may additionally offer maintenance and repair services.

   Many more services can be added, which are mainly sold after the initial selling agreement of the hardware. The CEO, thus, establishes an after-sales service department that is responsible for the new service business.

2. Naturally Grown
   Another approach to the establishment of a distinct after-sales service business could have originated through the recurring inquiries of customers demanding specific services. With the same developments on the customer side as mentioned above, they require the OEM to train their personnel on the new machines, as well as source maintenance and repair operations from the OEM instead of affording their own team.

   The OEM, most of the time, reacts by delivering customer-specific ad hoc service approaches, which seldom scale among the entire customer base. Another problem often arises with the expectation of customers to get such services for free as they paid quite some money for machine tools.

   Only by appointing new or existing teams to manage the increasing demand for services, it may be possible to build a coherent service portfolio.

Finally, the third stage of the servitization journey covers further development toward caring for customer success by combining products and services purposefully. As the maturity and proficiency of manufacturing companies in managing their service business increase throughout the servitization journey, they can concentrate on more advanced value propositions.

For instance, the machine tool manufacturer may realize that his customers only use the machines to do certain operations. In combination with the right services, the OEM could offer its clients these operations as a service. It would mean that the

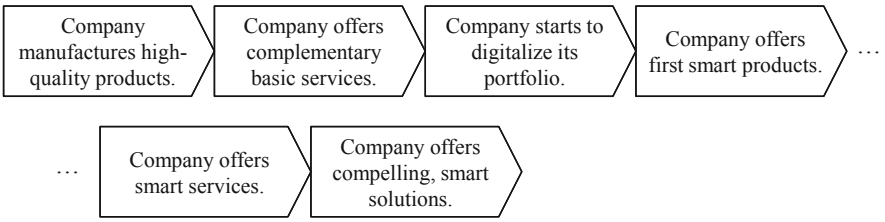

Fig. 2 Most common servitization journey. Own illustration

OEM ensures the continuous availability of its products to bill only the performed operations.

Evolving into such business models solves, for instance, the issue of the customer to care about the state of the machine and enables him to concentrate on serving his customers. But to reach the ability to offer such a solution, a myriad of aspects have to be met.

So far, we've followed the servitization journey of a manufacturing company offering traditional basic or after-sales services. The latest developments in the area of digitalization, however, enable companies to provide smart services.

Smart services combine the ability of products to transmit and receive data over secure Internet connections, with the intelligent processing of this data to create meaningful insights out of it.

While the stages described in Fig. 1 do not change due to the emergence of smart services, companies can meet the objectives of stage two and/or stage three based on both basic and smart services. Assuming that our machine tool manufacturer invests in the digitalization of his portfolio, his servitization journey will look like the most common found at manufacturing companies operating in a business-to-business (B2B) environment.

Condensed in Fig. 2, this servitization journey looks as follows:

The described journey entails manifold challenges—technologically, but also from a management perspective. Therefore, the book at hand should offer companies that find themselves somewhere along the servitization journey guidance in industrial service management covering traditional basic services and new, smart services.

2 From the Service to the Digital Paradox

Manufacturing companies that invest in delivering services are not single cases. This trend accelerated at the beginning of the twenty-first century, when academia and practice mirrored an increasing curiosity in discussing the potential of the service business.

However, many organizations realized early that the service business could not meet their prospected financial expectations. Instead, the investment and especially the continuous effort to develop, sell, and deliver services were frequently higher than the respective return.

The discrepancy between the expected financial success and the realized returns is called the service paradox (Gebauer, Fleisch, & Friedli, 2005). It was found that manufacturing companies, with a strong tradition in engineering and an affinity toward new technologies, lack distinct service capabilities. Even though companies excelled in developing hardware products, they were unable to establish a market-oriented and explicit service development process. The same holds true for creating relationship marketing and managing the interaction with customers meticulously. Further, manufacturing companies often miss a clear service strategy, which aligns with the overall corporate strategy. Concerning the organizational design, it was found that companies should opt for separating the service business to increase their focus. Moreover, nurturing a service mindset is a crucial endeavor to succeed (Gebauer et al., 2005).

Most of these topics were completely new to manufacturing companies, wherefore their financial success with the erected service business was limited. Managing industrial services from the perspective of a manufacturing company is not an easy task. Developing, selling, and delivering services successfully require other competencies, working mechanisms, partnerships, and even strategies. For organizations with a dominant engineering focus over the past 20 years or so, it is challenging to break with established routines. But as companies mature in their service endeavor, combined with insights from academia and successful practices, the challenges can be overcome.

Consequently, manufacturing companies that embarked on the servitization journey in the last 15 years might have overcome many of the difficulties connoted with managing the service business. Nevertheless, with the rising infusion of digital technologies within products and services (i.e., the development of smart products and smart services), they start to experience another new paradox—the digital one.

Even though many manufacturing companies have not yet streamlined their service business, they mostly cannot neglect the technological progress toward smart products and smart services. So, they see themselves confronted with the difficulty of making value out of data. This is where the digital paradox comes into play.

Famous quotes include expressions like “data is the new oil” and “information is key.” While the value of data is unambiguously high, the majority of manufacturing companies interpreted it the way that they should start to gather data—the more, the better. We often experienced that such companies thought once they have all the data, they can use big data tools or similar analytics to detect correlations, extract information, combine the insights, and share the value within the company or sell it outside the company. While it could work this way, the more plausible scenario will be to run into data overload.

Thus, the digital paradox describes the phenomenon of capturing data from sensors, processes, customers, external sources, and, wherever possible, without being able to transform the data into true insights and value, in turn, leading to notable revenues.

Another major issue is the fact that customers have to consent to the transmission of data. Just delivering the data back to the OEM for *free* is most of the time not a

valid option for the customer. Instead, manufacturing companies need to provide something in return.

Organizations face the danger of running into a digital paradox, or not getting data at all. Either way, these hurdles can be tackled by deliberately managing industrial services, digitalization, and the connection to the product business.

3 Distinguishing Physical and Smart Services

We already talked about different types of services before, which generally split into traditional, basic services and new, smart services. Both are industrial services (see Fig. 3). However, to sharpen the differentiation between basic and smart services, we introduce the term physical services as a replacement for the former expression.

Physical services share the characteristics of being manually conducted, offline, and analogous. Examples are, for instance, training schemes, maintenance and repair operations, and hotline offers. On the opposite, smart services are all kinds of services based on a minimum level of data or having a distinct digital component (Allmendinger & Lombreglia, 2005). Smart services range from remote monitoring options to pure platforms, somehow connected to the manufacturer's business. We have to note that there exist various other terminologies, such as remote services, teleservices, digital services, and data-based services, describing the same or similar offerings. However, we use the expression of smart services throughout the book at hand as an overarching term as defined above. It accounts for all existing terminologies and reflects the most well-known expression in academia and practice.

To clarify the distinction between physical and smart services, we apply the characterization of services along four aspects introduced by Cusumano, Kahl, and Suarez (2015): intangibility, variability, separability, and perishability.

In contrast to services, products are tangible and easy to standardize, the production and consumption occur separately, and they are storable. Physical services, such as training or repair operations, are still somewhat tangible and easy to standardize. However, the *production*—in this case, the delivery and its consumption—coincides, and it is impossible to *store* repair operations.

Smart services are commonly referred to as intangible and difficult to standardize, while the separability and perishability are ambiguous. One example is a predictive maintenance option. Sharing attributes of insurance, the customer cannot grasp what the algorithm is doing. Nevertheless, the program is stored in cloud or on-premise

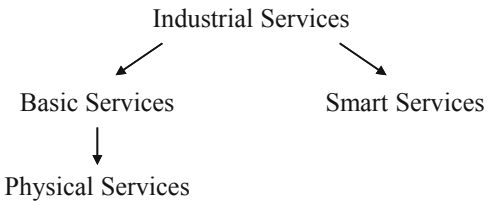

Fig. 3 Relation of service types. Own illustration

Table 1 Characterization of physical and smart services according to Cusumano et al. (2015)

	Physical services	Smart services
Intangibility	Somewhat tangible	Intangible
Variability	Easy to standardize	Difficult to standardize
Separability	Production and consumption occur simultaneously	Production and consumption are somewhat separate
Perishability	Cannot be stored	Can be partly stored
Examples	Training, maintenance and repair operations, hotline	Remote monitoring, predictive maintenance, performance benchmarking

servers, while the actual event of replacing a part before the breakdown of a machine occurs at the same time as its *delivery*.

Consequently, Table 1 provides an overview of the differentiation between physical and smart services, along with the four named characteristics.

4 Summary

In summary, many manufacturing companies did not yet transition successfully to a provider of products and services, less achieved further development in offering smart products and smart services. Technological progress enables companies to deliver entirely new, compelling solutions based on hardware and data. No matter where an organization stands at the moment, there exist serious challenges on the servitization journey. Often, servitization and digitalization endeavors culminated in the service or the digital paradox. It is, thus, vital to manage industrial services purposefully.

To support and guide manufacturing companies in this process, we designed the book at hand. The holistic approach to industrial service management introduced in Chap. "Introduction to Managing Industrial Services," and detailed in the subsequent chapters will help managers identify common pitfalls and solutions in the quest to a successful service business—covering both physical and smart services.

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Fundamentals of Industrial Service Management

Thomas Friedli, Philipp Osterrieder, and Christoph Tienken

The farther backward you can look, the farther forward you can see.
—Winston Churchill

Key Takeaways

- Services help to both differentiate from competitors and to increase profit margins.
- Successful service businesse requires an alignment with the firm's product business.
- A manufacturer's service strategy and organizational design have to reinforce each other.
- A holistic service value chain design is crucial to succeed in the service market sustainably.
- The customer is always the main point of origin for any service-related activities.

In parallel to the ongoing servitization of manufacturing companies, the increasing orientation toward industrial services should also lead to professionalizing industrial service management. Providing services imposes significant challenges for manufacturing companies not only in terms of delivering them to the customers but also in creating elevated requirements for the management of the firm. It is, thus, not only a technical discussion of how to develop and deliver services. To enable an effective, efficient, and profitable service business, several prerequisites have to be fulfilled. Before we introduce our service management framework, we will shortly

T. Friedli (✉) · P. Osterrieder · C. Tienken
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: thomas.friedli@unisg.ch; philipp.osterrieder@gmx.net; christoph.tienken@unisg.ch

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summarize some of the basic findings from our earlier work toward integrated service management in manufacturing companies. After the introduction of our current research framework, we will summarize the chapter.

1 Introduction

The management of industrial services holds several challenges. First and foremost, the complexity of industrial service management arises from the interdependencies and, even more, the possible trade-offs with the traditional product business and the legacy organization of a manufacturing company. As long as service had not been seen as a potential competitive advantage, there was no real need to set up a dedicated service organization with profit and loss responsibility. In the late 1990s of the last century, many companies started to anticipate service as an important factor for differentiation as well as a contributor to revenue and EBIT. However, many companies failed in transforming their business by expanding their service offer. Instead of higher profits due to increasing service revenues, they were confronted with higher costs and shrinking profitability. This phenomenon, also known as the service paradox (cf. Chap. "Servitization of Manufacturing Companies" (Gebauer, Fleisch, & Friedli, 2005)) leads to the question of how not only to define a sound strategy but also to manage services professionally. Therefore, we will briefly summarize some main challenges on the way from a product manufacturer to a solution provider and the respective implications for management.

1. There Are No Really Distinct Service Strategies
   What has been overseen for some time is that the transition from a product company to a service or solution provider along the product-service continuum (Ebeling, Friedli, Fleisch, & Gebauer, 2014; Oliva & Kallenberg, 2003) is not working in a way that one defined position on the transition path is exchanged against the new one. It will never be the case that every single customer can be moved to such a new strategic position. Ultimately, the move toward more services on the transition line means that all the requirements from the earlier positions have still to be taken into consideration. Ebeling et al. (2014), based on Gebauer (2008) and Fischer, Gebauer, Gregory, Ren, and Fleisch (2010), describe four generic service strategies along the product—service continuum the after-sales service provider, the customer support provider, the outsourcing partner, and the development partner—and describe what has to be adapted in the service portfolio, the organization, and the culture. However, even if companies build up the capabilities to become a development partner, they still have to be able to provide basic after-sales services like repairs reactively to customers who are not willing to give more responsibility to their suppliers. In summary, moving on the transition line means increasing the complexity and growing the service portfolio.
2. More Often than Not, There Are Potential Conflicts Between the Product and the Service Business

Putting a higher priority on services, setting up a dedicated organization, and monitoring the contribution of services to revenue and EBIT usually mean that as a consequence, the product margin comes under pressure. It is highly unlikely that customers are willing to continue paying the same price for the product when services are invoiced to them separately. In some cases, we have experienced that a service organization newly organized as a business unit started to provide its service offerings even to competitors, and this for a better price than what they charged to their own product lines in the company. This problem always came up when the service strategy was "only" developed for the service unit/function and not for the overall company.

3. Managing Service Portfolios and Service Innovation
   When service becomes a business, it has to be managed differently. Most early service initiatives just added new services to an already existing offering. There was no evaluation of the existing services and usually no management accounting figures about the importance or the costs of a specific service. Service innovation just happened without a structure, without a process, and mainly driven by internal ideas. For service portfolio management, it is again crucial to evaluate services from an overall company perspective. Some services are not designed to increase the EBIT, but they foster either product sales or help to increase the high margin spare-part business of the company. If these services were evaluated based on costs or profitability alone, they most likely would be eliminated, but the overall competitiveness of the company would be reduced.
4. Service Communication and Service Culture
   In the past, when a company identified the need for increasing the service business, an external communication initiative was usually launched, providing potential customers with glossy marketing material advertising the new service world. In a lot of cases, neither the service delivery processes were defined nor the internal communication was aligned with this. As a consequence, customers received inconsistent messages. Additionally, the brightest talents and best managers were seldom engaged in service-related functions. If service becomes a strategic priority, this has to be changed.

2 Conclusions

As a consequence of the challenges described above, we identify the following suggestions for professional service management from our early research:

- Develop your service strategy from an overall company perspective, and make sure that the top-level management is aligned.
- Consider that on the way to a solution provider, you still have customers that do not want any solutions from you. Thus, you have to make sure that you can manage the increasing complexity.

- Just increasing your service offering is not enough; you have to introduce a true service portfolio management, including tools to evaluate existing and new services.
- Your organizational structure for the service business has to support your defined strategy. The most appropriate structure depends heavily on the maturity of this business.
- There is a need for a systematic service innovation process.
- Service innovation includes the design and implementation of the respective processes for service delivery.
- To mirror the increasing importance of service, service has to become visible in internal and external communication. Talents and managers with potential have to be hired into service.

3 Dimensions of Industrial Service Management

Managing industrial services is a holistic endeavor for manufacturing companies comprising several dimensions. Displaying these dimensions in a framework makes the vague topic of industrial service management more palpable and accessible. Sometimes such a framework is referred to as the service business model (Kindström & Kowalkowski, 2014). Such a model helps to examine each dimension individually and guide manufacturers in creating a professional service business. Therefore, we continue by introducing the framework first before going into a brief description of each dimension covered by the framework and the book at hand.

3.1 The Industrial Service Management Framework

Industrial service management means organizing, or managing, the constituent parts of the service business. Since manufacturing companies might question which aspects they should cover, be aware of, or anticipate in the process of establishing industrial services, we facilitate the start by providing a framework containing the most important elements of successful service management. As we are driven to present a compelling book embracing all these relevant aspects to manage industrial services successfully, the framework illustrated in Fig. 1 serves simultaneously as the chapter overview for the book at hand.

In general, the service business model can be split into three layers. The first comprises the overarching subjects of the service strategy and the organizational structure. The second layer corresponds to the main operational processes (i.e., the internal value chain) of industrial services described as service innovation, service sales, and service operations. Further enabling activities, where we focus on, are customer relationship management and value networks; they reflect the bottom layer (Cf. Kindström & Kowalkowski, 2014; Posselt, 2018).

In contrast, Kindström and Kowalkowski (2014) describe 12 service business model elements, namely, *the service strategy*, *the structure*, *the offering*, *the revenue*

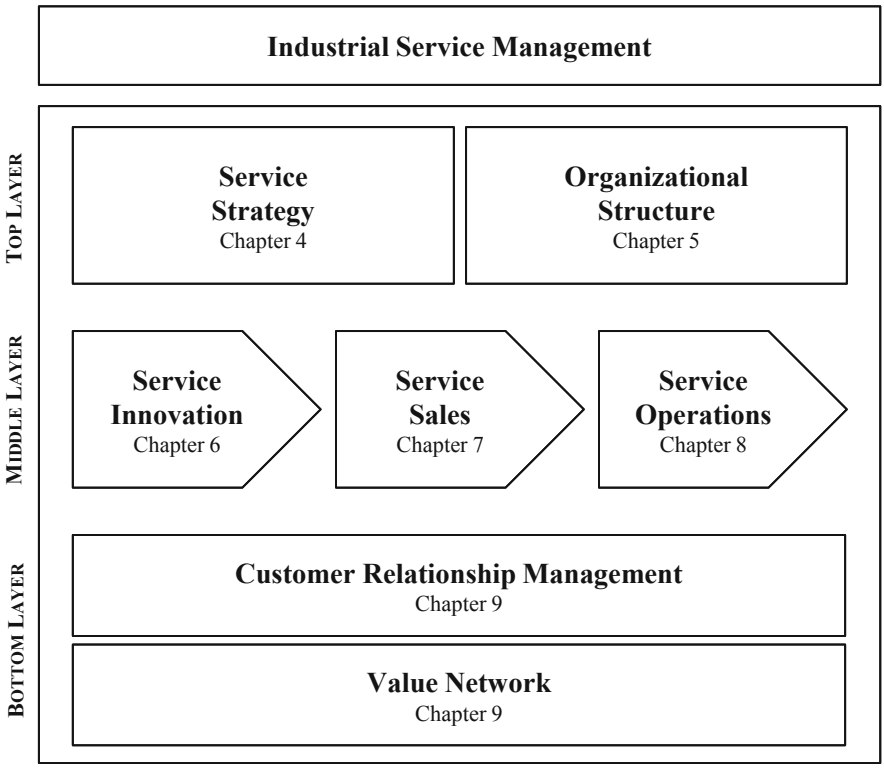

Fig. 1 The St.Gallen Industrial Service Management Framework. Own illustration

model, *the development process*, *the sales process*, *the delivery process*, *customer relationship management*, *value networks*, *culture*, *resources*, and *capabilities*. Our framework combines the offering and the development process within service innovation, as well as brings the revenue model and the sales process together in service sales. We do not dedicate separate chapters to the resources and capabilities, as these topics are naturally covered within each of the other chapters and therefore not explicitly integrated into the framework. Nonetheless, we acknowledge that having the appropriate resources and capabilities reflects an underlying necessity enabling the service business as a whole. The culture in terms of a service mindset is an important aspect for manufacturing companies as it influences the performance of the service business. An engineering-dominated heritage often opposes the customer-centric service culture, requiring firms to nurture the new mindset within their employee base. What a service culture is describes a rather philosophical discussion we do not want to open at this point, but we strongly believe that establishing purposeful industrial service management will help the manufacturer to grow the right mindset organically.

The framework, consequently, consists of the most relevant aspects from a practical point of view a manufacturing company should be aware of and manage

professionally to a lesser or greater extent when advancing toward physical and smart service provision. The remainder of the book dedicates one chapter for each of the dimensions shown in Fig. 1 with the exemption of customer relationship management and value networks that are described in one chapter. We further introduce each of the dimensions below and, hence, provide an overview of the topics covered throughout the book.

3.2 Top Layer

The first (or top) layer combines the two overarching topics having a strong influence on the consecutive operations. The service strategy, especially, reflects the starting point for all succeeding endeavors. Since the organizational structure naturally follows the strategy discussion, we begin with these two subjects in the upcoming paragraphs.

Service Strategy
Coming from the general corporate strategy, the service strategy is a functional level strategy based on a set of service-specific objectives. Formulating a strategy is an essential task in directing future activities supporting the agreed-upon objectives. However, while it may seem obvious that manufacturing companies should define a clear service strategy before heading into different directions, in practice, it often turns out differently.

Providing industrial services is repeatedly triggered by customers demanding specific support from the supplier. Manufacturers react with ad hoc approaches to satisfy customer needs. Ramping up the service delivery then leads to a situation where the organization is too busy for streamlining the service business with a clear strategic direction. Leaping the definition of a committed service strategy might then result in blurred objectives and inefficiencies.

A manufacturing company should, thus, act early by formulating a sound service strategy coming from two directions. First, the corporate strategy and corporate objectives mark the boundary of the service strategy and help to define the service businesses' contribution to the overall corporate mission. Second, a profound strategic analysis is required to account for micro- and macro-environmental developments, customer needs, internal resources and capabilities, and interdependencies with their own product and service portfolio.

Based on this bulk of information, the service strategy consists of five essential aspects: the objectives, the unique selling points, the portfolio, a make-or-buy evaluation, and the roadmap. As stated above, service-specific objectives play a major role in channeling further operations. Here, we differentiate between three general directions connected to three generic strategies, either focusing on improving the strategic position, increasing the market penetration, or increasing the income. We advise companies to concentrate on one main direction to streamline consecutive activities. The unique selling points describe arguments on the organizational level regarding why the company is in the best position to offer certain industrial services.

Results hereof shape the following portfolio discussion, entailing a plan including which industrial services the manufacturer should provide. The portfolio management includes four important elements (service selection, service evolution, service integration, and service bundling) a company has to derive with purpose. Afterward, the make-or-buy evaluation indicates which capabilities are required and how the firm strives to access the missing ones. The last part concerns the formulation of a roadmap, including planning the sequence of initiatives and defining how to start.

The Chapter "Service Strategy," covers all of the mentioned aspects and provides further details on, for instance, the necessary strategic analyses. Reaching an agreed service strategy is an essential step toward successful industrial service management and will lead to structural and processual adaptations, which are part of the other dimensions of the framework.

Organizational Structure

A direct consequence of a formulated service strategy is the organizational setup in terms of structuring industrial service activities. While reorganizing the current structure is likely not to be one of the first activities in the process of establishing a service business, manufacturing companies must adapt their organization sooner or later to foster success. Notably, scholars and practitioners agree that having an inappropriate organizational structure creates inefficiencies undermining the efforts put into providing industrial services.

The main challenge for manufacturers is then to combine the opposing philosophies of the product and service organization. The product business is commonly engineering-dominated and concentrates on research and development activities mainly located in the backstage of a company. In contrast to a typical service business, most employees are not situated in customer-facing units, leading to a less pronounced sales and service department, whereas services are based on customer-centricity and co-created value.

To cope with the divergent characteristics, including the culture of product and service organizations, manufacturing companies repeatedly chose to separate the service business. Its separation provided the possibility to nurture the service mindset within a set environment and to steer the business through its profit and loss responsibility. Yet, the advancements in digital technologies in the last years enabling smart services questioned the suitability of a separate service organization even before there were successful companies that stuck with an integrated organization.

Compared to physical services, developing smart services requires the cooperation of multiple interdisciplinary teams embracing at least the service department, IT, sales, and the product management department. Consequently, the manufacturer has to react to the new circumstances by deliberately integrating the industrial service activities within the existing organization.

We experienced that practitioners show a high level of uncertainty and seek support in finding the right organizational configuration in the transformational process toward providing industrial and especially smart services. Giving concrete

guidelines about how to structure the service business is, unfortunately, nearly impossible as organizations tend to be too unique.

Instead, we came up with a typology of eight different structuring possibilities for manufacturing companies that can be used throughout the reorganization process. Each of the eight types accentuates one particular configuration manufacturers can adopt depending on their contingencies. For instance, *Hub & Spoke* reflects one type combining the potential of bringing the focused development of digital technologies together with a dedicated market orientation of the service development by having a central digital unit and a divisional structure with service teams in each division.

We recommend to use the typology in a systemized manner by following the five steps: (1) reduction of feasible solutions, (2) screening, (3) pre-selection of preferred types, (4) prioritization of preferred types, and (5) customization and implementation. The eight types and the mentioned five-step approach are detailed in Chap. "Organizational Structure," but it is important to underline that not only one right or optimal solution exists. Depending on the current design, the service strategy, the similarity to the present business, and other influences, manufacturers can opt for one or the other organizational configuration leading to the necessity of adapting the operational core processes in the following.

3.3 Middle Layer

The definition of strategic objectives is paving the way for the value chain of industrial services. In this context, servitizing firms must be able to develop new services, sell the services developed, and run the operations of services sold. The value chain proposed in the framework, therefore, contains the following three operational core processes.

Service Innovation

The evolution of industrial services over the last decades is challenging every manufacturing firm that was used to produce and sell physical goods in the past. Despite the growing importance of the service business, enabled by ever-improving technical possibilities, a lot of companies relied on traditional product-oriented development processes. The ongoing transformation from being a traditional manufacturer to becoming a solution provider for the customer often did not impact processes that have been established for years. Today, more and more companies realize that the former understanding of product innovation and development has become obsolete and cannot necessarily be applied to new physical or smart services. With numerous limits being reached and innovation capabilities being hindered, we believe that the era of servitization, therefore, calls for a new way of innovating industrial services. Taking into account the pace of digital innovations nowadays, it is evident that time intervals for new releases are much shorter, and the speed of development cycles is much higher compared to classical hardware products. Moreover, the service claim of providing a solution is leading to an increased focus on customers' perspectives. Thus, servitizing firms need to be able

to both identify a customer problem and derive appropriate service solutions based on customer needs. Throughout the entire service development, several interactions with the customer can be used to validate the approach of solving a specific problem. Against the background of emerging smart services and growing competition in the market, solutions need to be delivered to the market much faster. As a consequence, companies will have to act much more agile and dynamic in terms of innovating services than they were used to in the past. The first element of the value chain is considering the major changes described above and, therefore, comprises a holistic innovation process that aims to fulfill all requirements of the digital age. Additional to the process structure itself, every organization must define roles and divisions that are involved in the different phases of the process. Especially due to the increasing relevance of customer needs and technical capabilities in the innovation process, a rethinking of rules is essential to overcome new challenges that are related to the technology or market. Furthermore, it is crucial to clarify where and how customers can be engaged in the process to test the current product and to obtain valuable input for future service development. Lastly, milestones or quality gates need to be defined in the process to freeze a certain status achieved and mark a point of no return in the otherwise more iterative process. Being the first element of the value chain, the Chap. "Service Innovation," forms the basis for all the following phases and represents the source of origin for all efforts that are dedicated to industrial services within a company. All downstream tasks in the value chain depend heavily on activities conducted in the service innovation phase, which underlines the importance of this element.

Service Sales

Industrial services that are developed also need to be sold afterwards. This implication consequently leads to the next important element of the value chain covering the entire process of selling industrial services to a customer. Manufacturing companies are faced with the question of how to market the different services coming out of the service innovation process. The development of new services always requires the service provider to think about a proper market strategy early on; specifically, companies that are used to mainly sell physical goods will have to adjust their established sales force to stay competitive in the market. A sales representative may only be incentivized by selling the core hardware products and see new industrial services as a burden in the daily business. Moreover, customers struggle to identify the actual value of intangible services that are offered to them and therefore expect them to be free of charge. For this reason, we see the need to realign both the internal sales processes and the communication to customers according to new requirements stemming from the increased number of industrial service offerings. This value chain element thus deals with the challenges in sales that companies need to overcome to successfully sell new services in the market. In this context, the first step is always geared towards a strategic sales dimension defining the objectives, followed by the introduction of industrial services to the market. However, this market strategy must be aligned with the aforementioned service strategy. Both the objectives and the installed base further help to derive these types of customer groups that are most

likely to use the service. At the same time, customer segmentation raises the question of how companies can obtain revenues from the services introduced to the market. The answer leads to a well-defined revenue model that is ideally based on the market strategy. Most importantly, the revenue model allows for discussing all components linked to the service offer and price, especially non-tangible services originating from new digital technologies that necessitate rethinking pricing approaches. The examples we have made clearly indicate that established pricing methods like cost-plus or competition-based pricing may no longer apply to smart and remote services due to a lack of either knowledge about the cost structure or similar services in the market. Instead, new approaches, like value-based pricing, gain in importance significantly and help to link prices directly to the value a service is creating for a customer. This shift from competition or cost-oriented to value-based pricing methods has a significant impact on the entire sales organization. The sales force, therefore, has to develop new capabilities to identify the use cases where customer value is created by the application of services. Furthermore, the service solution is compared to the next best alternative available, and the actual value can be derived and quantified monetarily. Successful monetization of industrial services only works finally if services, in general, are sold proactively and if the additional value is communicated properly to the customer. Yet, the sales force is often lacking a profound understanding of the service functions and their impact. Thus, existing sales channels, including key accounts, and current roles within the organization, need to be adapted to these changes to achieve the goals of the market strategy set beforehand. In sum, the Chap. "Service Sales," deals with all problems that appear in industrial services' go-to-market plans.

Service Operations

The last part of the value chain is represented by the operation of the service. Unlike most physical goods that are sold, the responsibility for industrial services does not expire after the sales process. Since service operations is an ongoing activity throughout the entire lifecycle of a product, this stage requires companies to build up suitable organizational structures and processes to operate services internally and deliver them to the customer as well. The different types of service offerings form the general basis and determine the required capabilities for this phase. Particularly with regard to the coverage of offerings, most manufacturing companies have gone through major changes over the last decades. After starting with classical machine installation and repair or spare parts services, new concepts like service-level agreements, availability guarantees, or as-a-service business models have been added to the service portfolio. Additionally, we see that the increasing globalization is shifting the angle of vision from a local perspective to a rather global perspective where companies need to solve customer problems worldwide. However, the main focus during field service or service delivery will always be on the technicians that are dispatched to support customers. The emergence of digital technologies thus will never make the work of technicians obsolete; instead, they open up new opportunities to improve the efficiency and effectiveness of activities conducted in this phase. For example, remote services allow customers to solve technical

problems without the physical presence of service technicians, but the expertise of humans is still essential to operate this type of service remotely. The new ideas coming from the front stages of the value chain always pose new challenges with regard to the implementation and ask for high flexibility and agility during service operations. Existing capabilities need to be refined continuously to control new processes and to train employees according to the new requirements. All ongoing efforts that aim to improve the service delivery or the service itself contribute to the continuous improvement process of the entire service organization. This process is mainly driven by key performance indicators (KPIs) and relies on the proper controlling of services. As a consequence, most companies started to professionalize their service operations due to customers that increasingly started to consider the entire problem-solving experience as a differentiation criterion. Additionally, companies took serious care of their service appearances in front of customers to increase customer satisfaction consequently. The shifting importance of products toward services resulted in the establishment of a company-wide service culture, which especially applies to the last part of the value chain. Taking into account the upstream value chain elements, we believe that it is crucial to follow an end-to-end principle and set up close collaboration among these three functions. Every type of service innovation that cannot be sold or lacks usefulness in operations must be identified early on to avoid unprofitable investment. Most importantly, the critical evaluation of new technology is always key to success within the scope of the entire value chain and ensures that services are delivered to customers smoothly. In conclusion, it is important to highlight the relevance of service operations in the Chap. "Service Operations," as it is representing exactly this part of the value chain, which is experienced and judged critically by every customer. The deployment of new technology is, in this regard, not supposed to replace technicians; instead, it aims to leverage both the coordination of internal processes and the service experiences perceived by customers.

3.4 Bottom Layer

Activities enabling the operational core processes characterize the bottom layer. We concluded above that in contrast to Kindström and Kowalkowski (2014), we do not dedicate a particular module for discussing the capabilities and resources of a company facilitating its servitization process. Nevertheless, we acknowledge that having the right capabilities, leveraged internally or sourced externally, is essential to accomplish the required tasks throughout the core value chain. Since these are part of each of the three value chain elements, we believe it is reasonable from a practical point of view to discuss the capabilities directly in the Chaps. "Service Innovation"; "Service Sales"; and "Service Operations."

It is of further value to have the right resources, in terms of people, money, and information, which we implicitly raise at some points throughout the book at hand. For example, the make-or-buy evaluation treated in the Chap. "Service Strategy," incorporates the view of whether or not the company has the right personnel with the

right competencies to overcome the new challenges imposed by servitization. Or, information from customers is of tremendous value for service innovation activities and consequently covered in the Chaps. "Service Innovation" and "Customer Relationship Management and the Value Network." Moreover, it may be noticed that appropriate financial resources are required to set up the service business, including the necessary infrastructure, technological development, and people. But we would like to highlight at this point that having plenty of resources does not determine success. Arguably, when a manufacturer has money and time, it will have the potential to derive new industrial services pleasing its customers and generating further profit. Empirical insights have yet shown that companies working under pressure coming from shrinking margins and profit or competitors can be equally successful, or they may equally fail. Consequently, companies should instead question what exactly they need and invest carefully as loads of money does not guarantee success.

One of these careful investments should be to professionalize customer relationship management. Customer relationship management and the evolution of value networks are two enabling activities found in the Chap. "Customer Relationship Management and the Value Network," which we introduce subsequently.

Customer Relationship Management

Customer relationship management is a broad concept originally referring to a technical system to process data coming from and about customers. Besides the technical component, it concerns leveraging and exploiting customer interaction for multiple purposes. Managing customer interaction in an organized manner will, for instance, increase internal efficiencies bound to customer data with the utmost objective of enhancing customer satisfaction. One practical example is Voith, who partnered with Salesforce.com to implement an integrated customer relationship management system to increase the transparency of and global access to customer information for faster reaction time and leveraging efficiencies.[1]

The implementation of such a holistic system became necessary since Voith experienced an evolution of company-customer interaction like most manufacturers do in the process of servitization. The established product-oriented business is characterized by transactional sales and value-in-exchange. With the rising importance of industrial services and a special focus on smart services, interaction becomes more and more continuous with the value generated in-use. Moreover, selling services often requires a consultative selling approach with longer sales cycles and more customer touchpoints as it is significantly more difficult to explain the characteristics, outcomes, and maybe consequences of an intangible, data-based service. Ultimately, the number of customer touchpoints increases substantially with the provision of smart services, supported by digital technologies, imposing the necessity to professionalize customer relationship management.

[1] https://www.salesforce.com/de/customer-success-stories/voith/

Companies can opt for leveraging digital interaction models, such as self-service systems (i.e., customer portals) to gather further customer data and converge the information at one repository. Channeling all customer information at one location enables inter alia faster reaction times, lower administrative efforts, lower susceptibility to errors, and better information sharing, thus leading to higher customer satisfaction. Implementing a customer relationship management system creates, however, technological and organizational challenges that need to be overcome. Still, we believe it is, for most manufacturers, inevitable to professionalize their customer relationship management, which is why we go into more detail in the Chap. "Customer Relationship Management and the Value Network."

Value Networks

Similar to the evolution of company-customer interactions, the emergence of value networks came along with an evolution of company collaborations. The former idea of a sequential value chain with the focal manufacturer having certain suppliers upstream and customers or possibly an intermediary downstream is replaced by a network of partners, complementors, service providers, and new entrants surrounding the manufacturing company. Surely, the company can profit from new partners' data-related capabilities to provide new kinds of services to customers, but it equally imposes new developments, challenges, and risks.

A major differentiation we present in the Chap. "Customer Relationship Management and the Value Network" is whether the manufacturer has a direct-sales approach or cooperates with distributors. We then elaborate on the changes for the firm along the six dimensions: (1) New and Existing Partner Involvement; (2) Redefining Service Delivery; (3) Financial Flows; (4) Data Flow, Data Access, and Data Ownership; (5) Customer Access; and (6) Vulnerability to New Entrants.

The general purport is that manufacturing companies see themselves confronted with various challenges, while they are typically less severe for companies having a direct-sales approach. Firms that cooperate with distributors need to embrace partner embeddedness and foster its partnership as the distributor plays a key role in enabling the manufacturer to receive data from the customer and counteract the threat of new competitors seizing the customer interface. Here, again, digital interaction models may help to develop the dealer network to deliver smart services and to tighten the bonds between the company and the dealer.

Managing the value network appropriately is an important aspect to enable the core operational processes. Partners and customer information are required in the service innovation section, service sales relate to supporting the distributor, and service operations encompass all involved partners and distributors to deliver a superior service performance. Consequently, manufacturers should be aware of the changes to the selected dimensions of the value network enacted by the servitization journey.

4 Summary

Coming from a heritage of manufacturing high-quality products and investing heavily in research and development to stay competitive or even advance the competitive edge, companies had to learn to cope with the early service business. As we have seen above, providing physical services can already impose significant challenges for manufacturers, since the applied methods, culture, and overall approach to do business differ substantially from the former product business. However, separating the service business and investing in a proper process alignment with the right talents relieved initial conflicts between the service and product world. Physical services share the characteristic of being mostly independent of the product sold, independent in the sense that their development typically succeeds and does not influence product development to a great extent. When a company is now maturing toward smart services, a simple separation between the product and service business is no longer possible. Most smart services cannot just be developed and provided in a vacuum. The products have to be able to transmit and/or receive the right data, with the right volume, and the right velocity. Cooperation between both departments is key and intensifies the challenges, as well as the complexity, for manufacturing companies.

This evolution requires firms to professionalize their industrial service management further along the seven dimensions described in the framework above. A service strategy needs to be formulated in strong alignment with the corporate objectives and top management. The organizational configuration has to support the defined strategy and enable the company to work effectively and efficiently. Operational core processes should be adapted with regard to the rising complexity of innovating, selling, and delivering smart services. Finally, the supporting activities of establishing a purposeful customer relationship management and accounting for the changes within the value network need to be managed appropriately.

Many findings from earlier research, which we delineated before, still hold true. Especially the results concerning the service strategy, organizational structure, service innovation process, internal and external communication, and the service culture are still relevant. Yet, the emergence of digital technologies and the development of smart services add further specificities and, in turn, increase the complexity and the need for further professionalized industrial service management.

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Service Strategy

Philipp Osterrieder and Thomas Friedli

In preparing for battle I have always found that plans are useless, but planning is indispensable.
—Dwight D. Eisenhower

Key Takeaways

- Defining, implementing, and adhering to a distinct service strategy are crucial steps to success for manufacturing companies.
- The corporate strategy has a strong channeling effect on the expected contribution of the service strategy.
- Besides corporate values and objectives, various strategic analyses are necessary to formulate a suitable service strategy.
- A service strategy contains five important dimensions: the objectives, the unique selling points, the portfolio, a make-or-buy evaluation, and the roadmap.
- While strategy definition is highly company-specific, three generic service strategies exist that focus either on differentiation, marketing, or financial objectives.

To be sustainably successful, a company needs a strategy. While having one is not the universal remedy ensuring survival, the absence of a corporate strategy may lead to blurring objectives about what the company should stand for, do, or provide.

A clearly defined strategy is a prerequisite for superior operations. When a company wants to be seen as one of the most innovative firms in the industry, its operative doings (investments, partnerships, recruiting, etc.) must emphasize

P. Osterrieder (✉) · T. Friedli
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: philipp.osterrieder@gmx.net; thomas.friedli@unisg.ch

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innovation. Equally, when an organization strives to provide "best-in-class" products and services, the results of the entirety of the employees' activities must signalize superior quality.

Taking the leap toward the service business of a manufacturing company, it should be clear what the strategic objectives to provide physical or smart services are. The role of services, especially in conjunction with the product business, has to be defined; if not, the company risks getting slowed down by power struggles and conflicting views. Consequently, having a service strategy derived from and embedded in the overall strategy is inevitable to manage industrial services successfully in the long term.

This chapter elaborates on the strategic planning process and describes the dimensions of a service strategy followed by an approach to define the service strategy. We end the chapter with a description of three generic service strategies.

1 On the Importance of a Service Strategy

We introduced that having a clear vision for the entire organization is a vital necessity for the succeeding activities of both the top management and employees of a manufacturing company. Based on that vision, senior management can derive its mission and targets, translated into key activities for the employees.

Further, the mission of the company shapes the corporate strategy, which, in turn, marks the boundaries for the service strategy. Where the corporate strategy embraces the long-term vision of what the company wants to achieve in the future, the service strategy focuses on what the service business should realize or contribute while complying with and reinforcing the corporate goals.

Yet, we have to be careful about what to call a strategy. A strategy is a plan of action aimed at achieving an overall long-term goal; therefore, for instance, the mission of a company or a particular organizational configuration is not part of the strategy itself (Hambrick & Fredrickson, 2001).

The service strategy reflects the fundamental purpose and values of the service business and defines the way forward. Consequently, the elements of a service strategy, as described below, need to mutually reinforce each other, converging into a clear picture that can be communicated to the employees, investors, customers, and other stakeholders.

Companies that fail to define an aligned and embedded service strategy will face serious problems, such as service or digital paradox described in Chap. "Servitization of Manufacturing Companies." Consider the following two scenarios for the machine tool manufacturer introduced in Chap. "Servitization of Manufacturing Companies," who finds himself at stage one of the servitization journey.

1. Progressing Without a Service Strategy
   At some point, customer inquiries increased to a number that the machine tool manufacturer decided to offer the requested maintenance, repair, installation, or training services to each customer individually. This ad hoc response leads to

high administrative efforts and manifold approaches with low standardization among similar offers. Ultimately, the company establishes a dedicated unit to cope with service inquiries. But without clear objectives of what the service business should achieve, they encounter the recurring phenomenon of an excessively growing service portfolio, as sales and service employees try to satisfy their customers with ever more individual solutions.

Consequently, the machine tool manufacturer starts to provide, for example, a relocation service and a 24/7 hotline because two customers thought it would be nice to have. Integrating such services into their own portfolio means creating process schemes, training of the affected employees, and much more internal effort—and this in light of a high uncertainty if those services will ever be sold again. Similar to the treated example, we have seen many more manufacturing companies offering multiple services that have only been sold once or not at all. It is, therefore, not reasonable to pursue such an approach to service management, as it requires vast resources with questionable returns.

2. Progressing with a Service Strategy
   It might be the same impetus to consider the setup of a service business, as in the first scenario, but this time a different approach is applied. Addressing the service business strategically means to decide which objectives the company wants to pursue (described as "what before how principle"). For instance, the CEO could choose to offer services close to products, as the emphasis should lie on supporting the product and product sales. Employees responsible for the service business development would look into the needs of the customers and match requests with the overall scope and purpose of the service organization.

   Installation, maintenance, and repair services will still find their way into the service portfolio of the machine tool manufacturer in this scenario, but offering a relocation service will most likely fall out of the scope.

   With this defined strategy, all activities are much more streamlined toward serving the communicated direction, leveraging capabilities and efficiency, accompanied by several other advantages.

These scenarios are a little exaggerated to accentuate the importance of a defined service strategy, and it might seem rather clear that the second case is the logical choice. However, there are many manufacturing companies organically evolving into providers of various services. It then happens repeatedly that such companies do not consider defining a set of objectives and a strategic direction while being busy delivering services to their customers and ramping up the service business in general.

This chapter strives to support manufacturing companies in creating their particular service strategy. Therefore, we continue with the introduction of a general approach toward strategy planning with a focus on the service strategy.

2 The Strategy Planning Process

Derived from the aspired vision of the entire organization describing the future-oriented purpose and core beliefs of a company, the mission statement formulates the company's fundamental determination and values in practical terms. The mission often embraces goal-oriented language and should not need major revision over time. Contrary, a company may regularly (re-)evaluate the corporate objectives derived hereof.

The corporate objectives consist of long- and short-term goals that reflect steps to achieve the company's mission. These objectives demonstrate a core input for defining the corporate strategy, as the strategy should formulate ways to reach them. We have to note that discussing the corporate objectives can either precede or be included in the process of corporate strategy definition. It can, therefore, happen that companies advance from the mission directly to the corporate strategy. Either way, companies require the delineation of corporate objectives.

The corporate strategy then focuses on describing a set of actions to accomplish the agreed-upon objectives. With evolving economic situations and company needs, the corporate strategy should be revisited after a particular period.

Figure 1 symbolizes the relationship between the vision, mission, corporate objectives, and strategy of an organization. It shows that based on the corporate strategy, a company commonly progresses with defining functional-level strategies. Functional-level strategies are characterized by a strong emphasis on details and

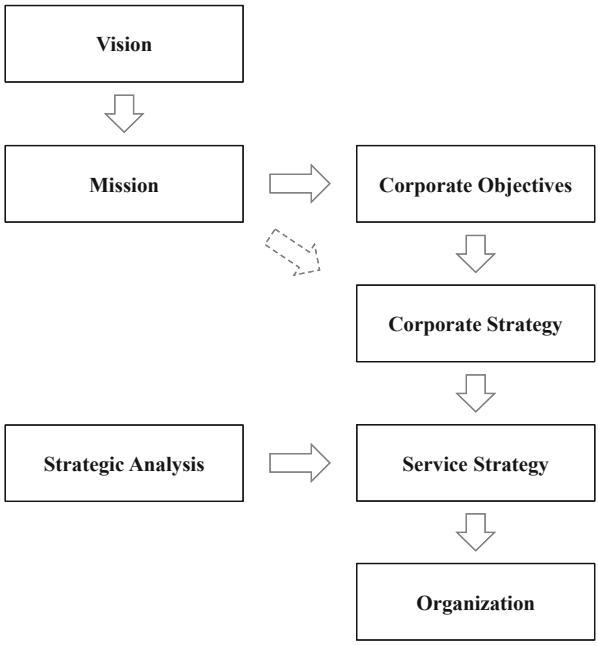

Fig. 1 The strategy planning hierarchy. Own illustration

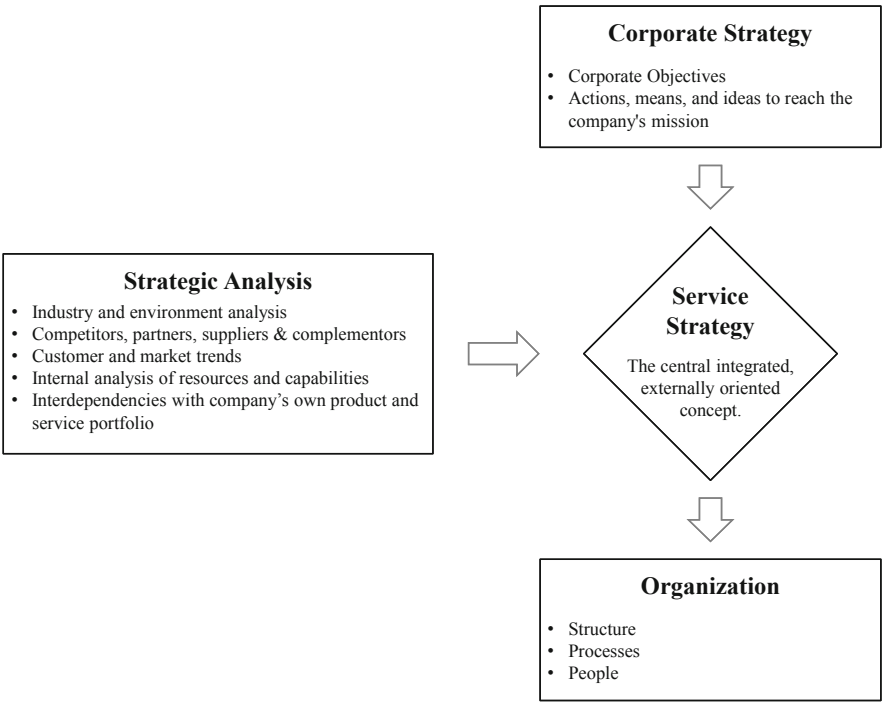

Fig. 2 Approach to strategy definition. Own illustration based on Hambrick and Fredrickson (2001)

practicality. They consist of clear and concise actions broken down from the corporate strategy to their specific context and needs. A functional-level strategy, here the service strategy, descends from the corporate strategy but also includes actionable results from manifold analyses, covering the macro- and micro-economic environment besides internal resources and capabilities. Finally, aligning the structure, processes, and people is part of the last action item called organization, influenced by the coordinated service strategy. Figure 2 shows the mentioned dependencies with a focus on the service strategy adapted from Hambrick and Fredrickson (2001).

When a manufacturing company is now planning to formulate a service strategy, it has to account for the role of the corporate strategy and address the required dimensions. We consequently discuss the stake of the corporate strategy in the following before transitioning to the core parts of a service strategy and how a manufacturing company might accomplish its formulation.

2.1 The Role of the Corporate Strategy

The corporate strategy determines nothing less than the degree to which a manufacturing company servitizes. It means that the company has to derive and decide the strategically most appropriate role of its service business, including the relation to the product business and the contribution to the overall competitiveness of the company. Does it strive to promote services as an add-on to foster product or spare parts sales? Or maybe the company wants to transform the entire business model shifting from selling the product to selling the use of the product supported by a bunch of classical and smart services.

Surely, it does not have to be to the extreme of one or the other. There exist several possibilities to position the company between service-as-an-add-on and product-as-a-service models. Moreover, a company can implement alternative approaches selectively. Michelin, for instance, opted for a pay-per-use model with a selected part of its business customers, whereas regular transactions are carried out with the major share of the customers.[1,2] Yet, managing ambidextrous behavior imposes high demands on mastering the complexity.

Within the corporate strategy, senior management has to state how the service should contribute to reach the overall goals (i.e., the mission) and how it serves the vision of the company. Thus, formulating the service strategy requires alignment on the senior management level to ensure the fit between the idea of what the service department should do and what the functional level wants to achieve. Therefore, the functional-level heads have to be part of the strategic planning process.

A conflict may arise when the strategic analysis on the functional level results in a conclusion that the best approach to win on the service side does not comply with the defined role of the service within the corporate strategy. Imagine the new corporate direction sets out the goal for the service department to gain significant importance in the customer process and provide services that substitute parts of customer activities. But the analysis reveals that the customers have no interest in strengthening the partnership. Instead, they favor quality products and services that support fast spare part delivery, suiting the current resources and capabilities of the service department. An outcome might be that a functional-level strategy has to cycle back and forth with corporate strategists to find the best fit and greater alignment.

Eventually, the role of the corporate strategy is to set a direction for the service strategists by breaking down corporate objectives to clear the expected contributions of the service department. Correspondingly, corporate-level objectives shape the functional-level objectives, which reflect the core of a distinct service strategy as presented subsequently.

[1] https://www.michelintruck.com/services-and-programs/michelin-fleet-solutions/

[2] https://digital.hbs.edu/platform-rctom/submission/michelin-tires-as-a-service/

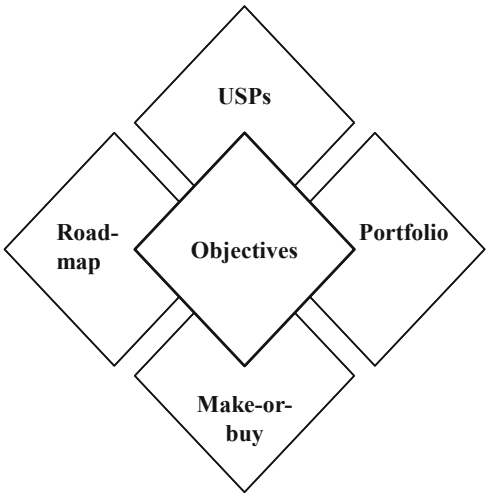

Fig. 3 Strategy dimensions. Own illustration based on Hambrick and Fredrickson (2001)

2.2 Dimensions of a Service Strategy

Figure 3 visualizes the main dimensions of a service strategy. Starting with the objectives centered in the middle, they reflect the core of any strategy. Being clear about the purpose of the service business translated into tangible objectives is imperative; therefore, companies should address this topic first. Once the company prioritizes the main objectives, it can move on with the other four dimensions.

In principle, there is not a strict sequence as the order should suit the background of the strategizing approach. It means, when a manufacturing company is trying to define a new service strategy based on an existing service portfolio, it can start with the portfolio discussion followed by the unique selling points (USPs), the make-or-buy assessment, and, finally, the roadmap. In case the respective manufacturer has not yet established a service portfolio, he can opt to begin with the USPs and then continue with the portfolio discussion, the make-or-buy analysis, and the roadmap.

The remainder of the chapter will concentrate on manufacturing companies that start to introduce new industrial services. Companies that find themselves in a slightly different situation might consider approaching the strategic planning process from another starting point. Ultimately, all five dimensions and the underlying analyses presented below need to be met at some point throughout the process.

2.2.1 Objectives

In general, we distinguish three main objectives that split up into 19 concrete goals on the lowest level, displayed in Fig. 4. If a manufacturer encounters the problem of prioritizing the *right* objectives, answering the subsequent questions might help: Why do we need physical and/or smart services? What do we want to achieve with them? How do they fit into the corporate strategy?

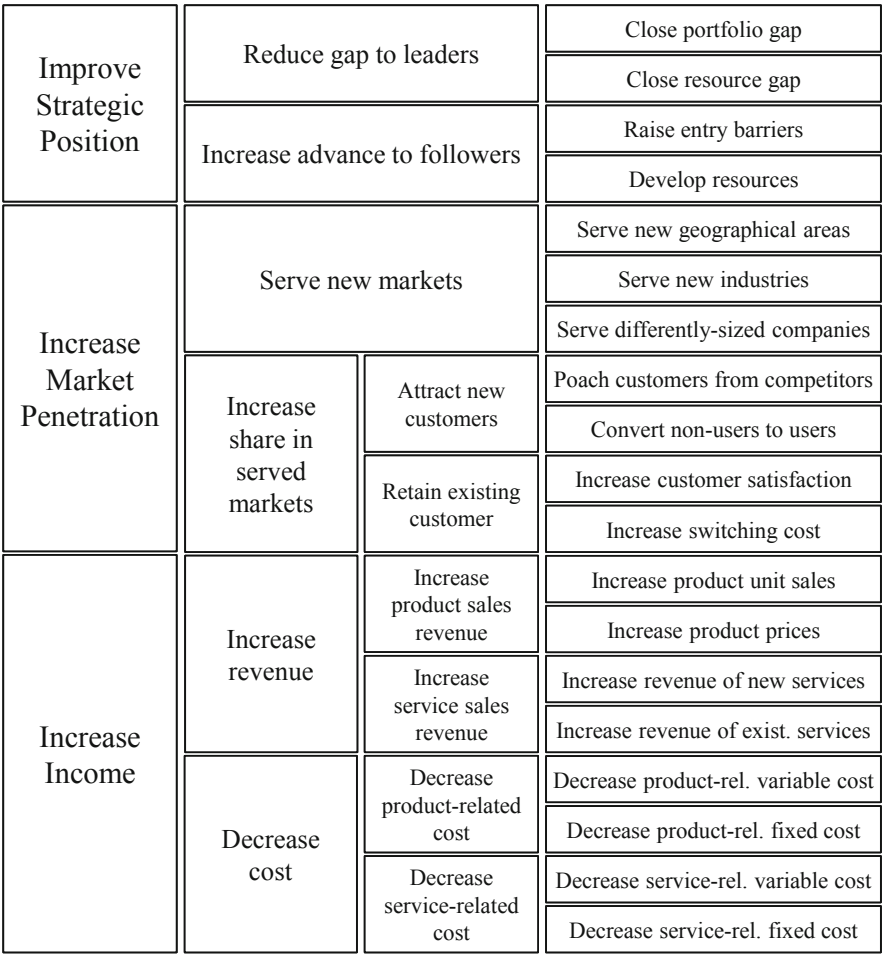

Fig. 4 Strategic objectives tree. Own illustration

We recommend companies to prioritize one general strategic direction to streamline all related operations on reaching it. Therefore, we present the possible pathways resulting from each objective subsequently.

The first general objective aims at improving the strategic position. In this case, the service business should support the overall objective of enhancing the differentiation between their own manufacturing company and its competitors. Because of the described intangible nature, services are difficult to imitate and can be a source of competitive advantage. Therefore, depending on the situation in which the company finds itself today, it can opt for either increasing the advance to followers or reducing the gap to leaders with their service business.

The second first-level objective is a company's impetus to increase the market penetration of the hardware products in two ways: first by increasing the share in markets already served and second by conquering new markets.

In the first case, the services should support retaining existing or attracting new customers. Developing the right services can, thus, increase switching costs and customer satisfaction to strengthen the bond with customers. On the opposite end, the service business might also help to convert non-users of the companies' products to users or even to convince customers from competitors to switch the provider.

The second case describes the endeavor to conquer new markets with the support of new service portfolio. Here we differentiate between the objective to serve differently sized companies as the focal firm does today, to enter formerly unaddressed industries, or to deliver the products and services to new geographical regions.

The last main objective is to increase income. Services often provide additional and more stable revenue streams; additionally, they are typically associated with a higher profit margin than product sales. The surplus of revenue from the service business can help to compensate for decreasing margins from the product business as increasing competition frequently leads to the commoditization of hardware products. Or, it could be an approach to grow as an organization.

Thus, companies that focus on increasing their income can do so by either decreasing existing costs or boosting the revenue. A manufacturing company can follow each direction in two ways: first by decreasing service- or product-related cost and second by increasing service or product sales revenue with the purposeful provision of selected services.

Successful companies usually concentrate on one specific strategic direction and then adjust their processes, activities, and other necessary positions to accomplish that goal. Emphasizing one specific objective does not, however, mean that the then-developed industrial service may not serve other lower-level goals as well. For instance, improving the spare parts delivery service by providing a consignment stock inside the customers' factory can raise the barrier for customers to switch to another supplier and increase customer satisfaction due to shortened downtime in case of a failure. Similar results may occur for any objective. Nonetheless, companies should define a clear hierarchy among the pursued objectives. In this category, the most common approach is to focus on increasing revenue through new services.

Manufacturers often want to grow by introducing new services that delight customers and surprise competitors. However, real-world evidence shows a different picture. Selling completely new services is hard, especially when references are scarce and few to no comparable offers exist due to the novel character of the industrial service. In such a setting, customers might not want to pay the price commanded. This undermines the goal of increasing the revenue with new services. Manufacturers then pivot toward offering advanced physical and smart services that slowly teach their customers the benefits of data sharing.

When discussing the possible objectives described above top-down (from left to right in Fig. 4) and bottom-up, we repeatedly experience that manufacturing companies differ between a short-to-medium-term and a long-term perspective.

At first, manufacturers underline that the service business needs to be financially successful and and that it contributes with a substantial margin surpassing their own cost. This applies especially for the new smart service business. However, deeper into the discussion, managers in charge highlight the focus on non-financial objectives (particularly increasing customer satisfaction, raising the entry barriers, or converting non-users to users are common choices) in the short term, always against the financial sustainability in the long run.

Even though we encourage focusing on non-financial objectives in the short term and financial objectives in the long term, strategy formulation may cause conflicts within the company. Problems arise, such as: How can manufacturers resolve the problem of rigid business case-oriented service development decisions for offers that might have a significantly positive influence on customer satisfaction (short-term non-financial goal) but with questionable profitability? Or how can the company measure a single service's contribution to the return of the entire organization in case it is sold for a low fee but facilitates additional product sales?

Deciding for specific objectives should streamline consecutive operations of the service organization but can imply significant challenges for established accounting, decision-making, and controlling mechanisms. The key is to show and communicate transparently why the service organization focuses on the one or the other goals, aligned with the corporate strategy and promoted by top management commitment. Differentiating between short- and long-term objectives may consequently lead to an altering service strategy over time.

2.2.2 USPs

When the manufacturing company agrees on the hierarchy of objectives for the service business, it can address the service business's USPs. As part of the service strategy, the USPs do not focus on single reasons why customers should buy a certain service. Instead, the company should delineate the unique argument of why it is in a certain position to deliver superior services.

Ask, what makes a manufacturer predestined to offer industrial services? It may be that the company offers products along the entire core value chain of its customers, whereby they are highly dependent on the provider. Or, the manufacturer equips customers with the core product reflecting the highest bottleneck in the process, requiring maximum availability. Maybe the company already established a strong data analytics department due to its product portfolio and is able to deliver a best-in-class product, service, and software package from a single source.

USPs can be manifold and enable the company to think of their strengths on the organizational level, shaping the portfolio discussion in the following.

2.2.3 Portfolio

The portfolio covers the evaluation of which physical and/or smart services the focal company should offer, to whom, where, and how. Seldom can managers in

charge answer these questions right away. The company has to look into the market, what the customers need, what the competitors provide, as well as what the organization can deliver.

While the manufacturer requires information from the necessary analyses detailed below, it is a strategic question of how the company sets up its service portfolio. Strategic considerations should treat how the company can evolve its service business and how the new industrial services may cannibalize existing services or products.

The former strongly relates to a purposeful alignment of externally oriented activities in light of the defined objectives. Perhaps, a manufacturer pursues the goal of creating maximum availability of its products through a variety of remote and predictive smart services, but there is not a single data connection to the customers in place today. This leads to the question of: How should the company develop predictive algorithms without any real field data? The finding requires the manufacturer to plan and provide advanced physical and first smart services stepwise to establish a profound relationship with the customer to obtain his data and slowly learn from it. Manufacturers should, thus, consider the evolution of the service business to achieve the set goals.

The company must further treat the risk of cannibalizing existing businesses with new industrial services during the strategic planning process. Analyzing the interdependencies among the product and service business is part of the strategic analyses and introduced in the next sub-chapter.

The fourth aspect of the service portfolio that has to be addressed is the general approach toward bundling. Companies may decide whether they strive for bundles at all and, if so, how the bundling strategy should be. It is possible to differentiate between a pure, mixed, or modular bundling either oriented toward the customer process, products, or business.

The service strategy contains with the service portfolio an element reaching further than only selecting the right services customers want and companies may provide. The portfolio strategy also covers how strategic objectives can be attained by the evolution of the service offers and how the selected services can be integrated within the existing portfolio. It further pertains to the manner in which a company may bundle its hardware, software, and service products. Table 1 summarizes these four elements together with their main characteristics.

2.2.4 Make-or-Buy

When a manufacturing company tries to introduce new industrial services, it commonly necessitates new, currently unavailable capabilities. Therefore, the company needs to find out which specific new capabilities they require. In a second step, the organization has to define how to get access to these missing capabilities.

As make-or-buy implies, managers may choose to develop the resources internally or to source them from the outside. Both approaches have certain benefits and drawbacks.

For instance, establishing competencies to work with data (coding, data transmission, data processing, etc.) can lead to a competitive advantage in the future, as the

Table 1 Important aspects of the strategic service portfolio

Service portfolio elements	Characteristics
1. Service selection	Based on: – Customer needs – Trends and market environment – Internal capabilities – Objectives
2. Service evolution	How-to: – Status quo analysis – Definition of intermediary services – Customer development – Capability development
3. Service integration	Based on: – Existing products – Existing services – Complement or cannibalize
4. Service bundling	How-to: – Pure, mixed, or modular bundling – Process-, product-, or business-oriented view of value-based bundling

Source: Own research

company can capture important information and attempts to translate this information into added value. However, building up these competencies is likely to take a long time. Partnering with a specific software provider would accelerate the development of a new smart service, but it entails significantly less knowledge accumulation or even loss of knowledge, depending on the individual agreement with the third party.

We experienced that the importance of being able to handle data in any form will rather increase than decrease. Therefore, we advise manufacturing companies to invest in developing the appropriate capabilities. Developing the capabilities internally can as well mean partnering with third parties to learn from them in the long run. Essentially, manufacturers need to manage the inherent trade-off between speed and internal capability development.

2.2.5 Roadmap

The last aspect of the service strategy is to define a roadmap. The roadmap includes planning the sequence of initiatives and defining how to start. It is strongly connected to the explanations on preventing the service and the digital paradox, as well as the service evolution described above.

Consequently, manufacturing companies have to state with which initiative to start and how to continue. In practice, an organization usually wants to provide multiple services when advancing the service business to provide smart services. But as it is unlikely to introduce all services at the same time successfully, manufacturers should adhere to the planned service evolution and begin with a reasonable choice. It is, therefore, vital to create a sequence of events. For this purpose, the company has

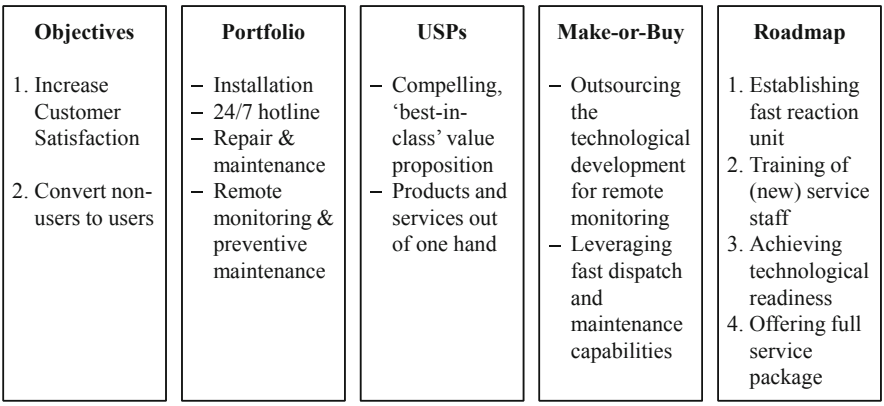

Fig. 5 Simplified service strategy of the example company. Own illustration

to be aware of the required capabilities (cf. make-or-buy) and any other necessary activity, which can then be assorted on a timeline.

The five elements, objectives, USP, portfolio, make-or-buy, and roadmap, make up the service strategy a manufacturing company has to define when it intends to increase the importance of its service business. A plethora of analyses, discussions, and decisions need to be carried out by the companies to reach the point of a formulated strategy. While the subsequent chapter covers the necessary steps to do so, consider first the example of a simplified service strategy connected to the mentioned machine tool manufacturer shown in Fig. 5.

The primary objective of the machine tool manufacturer is to increase the satisfaction of their customers with their products. As we indicated before, the CEO envisions the service business as a vehicle to foster product sales by caring for customer needs and problems. Therefore, the company decides to build the entire service portfolio around the goal to make the customer operate the companies' products as hassle-free as possible. Since the availability of the machine tools is key, the company focuses on services enabling optimal usage (installation, maintenance) and fast reaction to failures (24/7 hotline, repair). The machine tool manufacturer even plans to offer new, smart services (remote monitoring and preventive maintenance) to further increase the availability.

Due to the unique position of providing a compelling value proposition, consisting of products and services, out of one hand, the company can differentiate itself through superior quality, fast reaction times, and right-first-time, culminating into best-in-class availability.

With the accentuation of the service business as a vehicle to support product sales, the CEO does not want to invest vast resources in developing technological capabilities for providing remote monitoring service internally. Consequently, the company partners with a third party to fill this gap and concentrates on leveraging the fast dispatch and maintenance capabilities.

Essentially, the machine tool manufacturer prioritizes the internal development over offering the smart service, whereby activities concerning the fast ramp-up of the service personnel and business precede the technological development.

This summary of a potential service strategy for a medium-sized machine tool manufacturer exemplifies the key elements it should comprise. To arrive at such a summary, we propose to accomplish multiple analyses and go through the approach to strategy definition presented below.

2.3 Approach to Strategy Definition

The approach to strategy definition is a holistic endeavor, as shown in Figs. 1 and 2. The mission, the corporate strategy, and various analyses shape and sharpen the service strategy, which entails necessary adaptions to the organization.

Some of the required information may already be readily available within the company. But as we strive to offer guidance in the entire strategy development process, we briefly discuss every single step.

2.3.1 Industry and Environmental Analysis

Analyzing the environment of a company helps to consider important market developments. The macro-environment contains factors that affect all organizations within the industry equally, and that cannot be controlled by a single firm. Collecting these factors systematically provides the opportunity to tackle potential influences proactively, and it attempts to inform managers or employees about the current developments. Capturing such information is often not explicitly "valuable" for the company at first, as most managers have tacit knowledge about the most crucial developments. Nevertheless, it helps to better grasp the existing challenges and offers valuable input for the ideation process of service development.

For instance, when a company intends to offer smart services, it may question how digitalization will impact the macro-environment and the industry. The manufacturer has to uncover the industry logic, including the business boundaries, how the industry might evolve due to the anticipated impact, and what the firm's position in this development is or can be.

2.3.2 Competitor, Partner, Supplier, and Complementor Analysis

Besides examining the larger business environment and trends affecting the companies' industry, it has to consider its customers, competitors, partners, suppliers, and complementors. Since the customers reflect a special focus group for companies, we treat them individually afterward.

Starting with a competitor analysis, companies must be aware of the key strengths and weaknesses of each competitor, comprising existing competitors from the product business and potentially new, formerly unaddressed competitors from the service or software area. Therefore, a company can begin by asking who are the most important competitors and whether there are new ones related to the service business. The manufacturer has to question who is winning, and why. Besides

delineating the strengths and weaknesses, it helps to identify the current strategic direction of the competitors and their activities toward physical and/or smart services.

In addition to the task of analyzing traditional and non-traditional competitors, manufacturing companies should characterize suppliers, complementors, and further partners. Being clear about the abilities and potentials of these three groups can influence, for instance, the strategic position of the focal company and service development.

Drawing a value creation network can be a tool to display the relations between the involved organizations and might reveal potential challenges. Imagine a manufacturer that distributes its products through a reliable network of non-exclusive dealers. In this case, the manufacturer often does not possess continuous contact with the final customers. While it usually works for hardware products, not having these contacts with customers makes it extremely hard to develop services. Developing services requires much more customer knowledge and customer interaction, wherefore this position may be vulnerable to other parties connecting directly to the customers. See Chap. "Customer Relationship Management and the Value Network" for details on the value network.

This analysis provides direct inputs for the service development, service portfolio, USPs, and the make-or-buy assessment within the service strategy.

2.3.3 Customer and Market Trend Analysis

As highlighted before, a company should invest time into analyzing its customers. It is wrong to think that a manufacturer may offer every service to every customer equally. Hilti started to provide its fleet management service many years ago, but first only to a selected customer segment (Baumbach, 2005).

Therefore, it is worthwhile to begin by elaborating on customer segmentation. This exercise is about how the company segments existing and potential customers, what the relevant criteria are for customer segmentation, and, finally, which segments exist for these criteria. Differentiating between region, industry, and product group occurs frequently. But a company may also choose to look into customer needs or their maturity in the field of digitalization, their willingness to outsource, or their knowledge regarding the use of the physical products and their capabilities to maintain these products.

Once all segments for all criteria are listed, the organization has to select one or more groups that seem to be most receptive to novel services. Customer segments that tend to be early adopters or have the highest benefit are the prime choice, especially when introducing smart services. But as long as a manufacturer can argue rationally why it will focus on a particular customer segment first, it can be any part of the customer base. Examining and understanding customer behavior within these segments is key for future endeavors and is detailed in Chap. "Service Innovation."

Equally, it is reasonable to screen market trends. Knowing where the market and the customers are heading in the future provides further inputs for strategy definition. Combining the information about market developments and customers strongly guide service development, as well as the final portfolio and the roadmap.

2.3.4 Internal Analysis of Resources and Capabilities

Whereas the previous analyses mainly scope the portfolio and roadmap, the internal analysis of resources and capabilities has a far-reaching impact beyond the make-or-buy assessment. It is one thing to understand what a company can accomplish, where the strengths and weaknesses lie, but it is demanding to translate this information into acquisition recommendations, USPs, and a sequence of activities to remedy revealed deficiencies.

But first, a company has to identify where it can build on context-relevant resources and capabilities. One approach may be to start with clarifying the core competencies of a company by testing whether competencies make a significant contribution to the customer and/or are difficult to imitate (Prahalad & Hamel, 1990). Going further, the company delineates on which competencies it can count for particular services and the establishment of the service business. The process is, thus, to start from general competencies and narrow them down to more specific resources and capabilities, leading to an estimation where gaps exist to required competencies.

Yet, we propose to follow an alternative way of analyzing the companies' capabilities. In essence, the available capabilities would shape the solution space of which services the company could provide to the customers and therefore impact the service portfolio. But, to clearly define the required competencies for a particular service, we need to know about which service we are talking.

To solve this contradiction, we suggest ideating first services based on previous analyses and the firm's existing (core) competencies. The one or two most promising service ideas are then concretized through, for instance, the value proposition and business model canvas (Osterwalder & Pigneur, 2010). The hereby available information can be examined further by deriving and validating (or rejecting) hypotheses connected to the services. The hypothesis-driven capability assessment describes one possibility to delineate deviations and find open action items.

Consider the following example to clarify the approach of a hypothesis-driven capability assessment. In the course of ramping up the service business, the mentioned machine tool manufacturer realized significant increases in tool availability and, in turn, higher customer satisfaction. As the CEO is happy about how his strategy worked out so far, he strives to develop the service portfolio further. One idea, coming from customer feedback and risen at ideation workshops, is to create a dashboard where the customer views the current status of all tools. It helps not only the customer to maintain operations more efficiently, but the manufacturer can use this aggregated information for multiple additional purposes. Scoping the new visualization service unveils that the user interface and user experience are crucial for external and internal adoption rates. Thus, while addressing the internal capabilities to deliver that service, the CEO follows a hypothesis-driven approach and questions, among others: Are we able to design the user interface and user experience on the required level?

A hypothesis-driven capability assessment comprises questions that point to the underlying assumptions of a value proposition and the corresponding business model. Here, the CEO assumes that the service requires a superior user interface to

be successful, wherefore he creates one hypothesis to test whether the company can deliver this performance.

Creating hypotheses naturally precede their validation. The company consequently has to assess all pronounced hypotheses to which degree they are capable of addressing the underlying assumptions or whether they lack the respective abilities.

The result is a set of hypotheses and statements to which degree the company is capable of reacting to them. A possible response to the mentioned question may be that the company has basic knowledge in designing the user interface and user experience but misses the appropriate proficiency.

With honest evaluations and answers to all hypotheses, the company enables the creation of a clear picture of what it can do and cannot do. This information is tremendously valuable to determine whether the existing gaps should be closed by sourcing from the outside or by leveraging capabilities internally.

The problem is that now strategic and operative boundaries blur. On a strategic level, the manufacturer should be aware of general capabilities and deficiencies by analyzing them throughout the service strategy planning process. But concrete action items concerning what the company is capable of realizing or not may only be revealed in the operative doing of service innovation (cf. Chap. "Service Innovation"). Concerning the superordinate service strategy, it can be enough to formulate general capabilities and deficiencies for the provision of industrial services. Yet, manufacturing companies have to assess the depth of their capability evaluation individually at this point.

2.3.5 Analysis of Interdependencies with Company's Own Product and Service Portfolio

In the process of defining the right service portfolio, it is not only important to look into the capabilities, needs of the customers, market trends, competitor situation, and macro-environmental influences, but the company should also consider its existing offers. The general question is whether the new physical and/or smart services tend to cannibalize or complement the existing business.

BMW designed the i3 and i8 so differently because they wanted to attract non-BMW drivers to the electric car models. As a result, about 80 percent of the i3 and i8 owners switched from another car brand to BMW.

Equally, manufacturing companies should examine potential interdependencies among the existing portfolio. Maybe a company is making a substantial amount of money with their spare parts business, whereby additional services should support spare parts sales rather than substitute it. An intelligent consignment stock or a well-designed customer portal for easy online ordering could supplement and foster spare parts sales, while a print@home additive manufacturing service for customers to create licensed spare parts could lead to margin loss.

Another example is the discrepancy between preventive and predictive maintenance. Imagine a manufacturing company is making notable margins with quarterly service visits at customers to maintain its products. Each visit contains a travel lump sum, several working hours, some spare parts, etc., culminating into a regularly

billable sum customers are willing to pay for as they experience the service encounter. In contrast, a working predictive maintenance service might lead to lesser service visits with higher first-time fix rates and fewer billable working hours. Combined with the customer's reluctance to pay great amounts for an intangible algorithm that is working in the background, the manufacturer could end up with a negative business case compared with maintaining its products preventively. Yet, the received data from a predictive service can create highly valuable insights into product usage for product improvements or as an input to further service innovation.

Even though it might sound obvious, it is necessary to think about potentially undesired and unintended consequences that could lead to adaptions of the service portfolio. It may not always be possible to conquer completely new customers as BMW tried to, and, depending on the strategic objectives, it may not even be the goal. Nevertheless, a company should manage the interdependencies carefully as it could also open up the possibility to offer new bundles of services and products. Hence, interdependencies do not always have to be negative.

For instance, when the machine tool manufacturer thought about introducing the new dashboard service, the CEO was aware that it strongly connects to the remote monitoring service. Information that is transferred to enable the latter service is a valuable input for the former one. Therefore, those companies that already pay for the remote monitoring service are likely to have the technological readiness to use the dashboard right away. Consequently, the manufacturer may opt to bundle these services in the future and provide attractive pricing plans.

Interdependencies among new industrial services and the existing product and/or service portfolio can create both positive and negative outcomes. Providing a uniform approach to solving this issue is, however, difficult. Manufacturing companies should look into the characteristics of their new industrial service and compare it with existing offers to derive necessary actions. Companies might consider the flowchart in Fig. 6, which points to supporting practitioners in finding appropriate measures to counteract potential overlaps.

3 Three Generic Service Strategies

We advise manufacturing companies to follow the necessary steps and pursue the relevant analyses described above to derive an individual service strategy contributing to the overall corporate strategy, as well as suiting the company's mission and vision. Nevertheless, we distinguish between three generic service strategies connected to each of the main objectives (cf. first column of the objectives tree in Fig. 4) and logically inherited from previous seminal work of Porter (2004) and Miles, Snow, Meyer, and Coleman (1978) adapted to the present context.

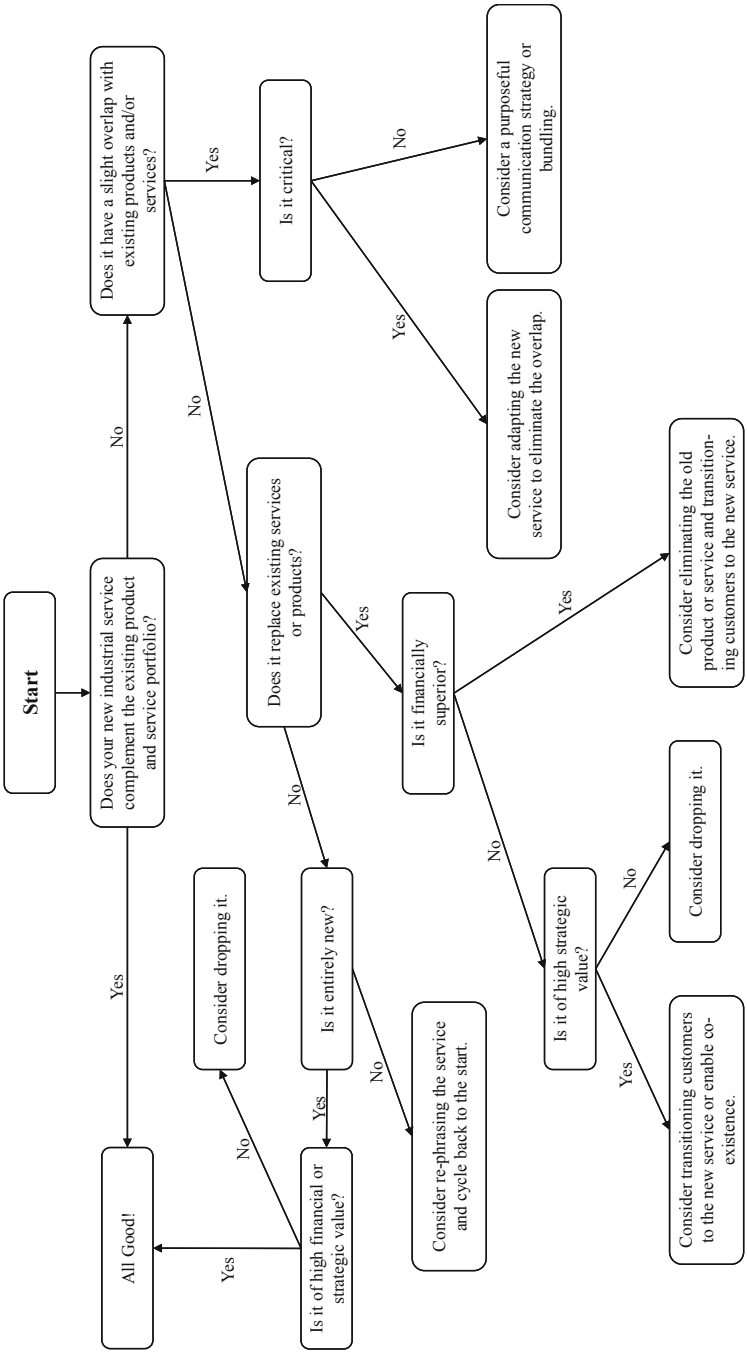

Fig. 6 Portfolio interdependency decision flowchart. Own illustration

3.1 The Differentiation Strategy

The first generic strategic direction highlights the objective of the manufacturer to establish a service organization as a strategic business supporting the differentiation to competitors. It can mean to raise entry barriers by developing industrial services that interweave tightly with the customer process.

Following a differentiation strategy often implies investing substantial resources into the service business as the company strives to develop it with a distinct purpose. Novel services will be created, and new capabilities or talents are required.

The service strategy is, thus, a key contributor to the corporate strategy to attain a specific position in the market. Market leaders, especially, may opt for a differentiation strategy as they are in the prime position to defend and advance their competitive edge against followers.

3.2 The Marketing Strategy

Manufacturing companies wanting to increase market penetration mainly apply a marketing strategy. Typically, the marketing strategy entails a pronounced focus on the product business compared to the service business, whereby industrial services primarily serve as a means to foster product sales.

Companies that select this strategic approach can have varying reasons to do so. We know manufacturers selling highly superior products with such a high market share and reputation that services should merely support maintaining customer satisfaction or increasing switching costs. Other companies may be in the unfavorable position of supplying their customers with standard or non-core products, where the customer's interest in strengthening the relationship is limited. Industrial services could then serve to raise the product attractiveness to increase customer satisfaction or poach customers from competitors.

Manufacturing companies following this strategy are likely to shun investments into the service business as services are often given away free of charge or included in the product acquisition price. Consequently, the marketing strategy commonly relates to a general cost or quality leadership strategy.

3.3 The Financial Strategy

The last generic strategic direction emphasizes the objective of the service business to increase the total income by either increasing product- or service-related return or decreasing cost. The financial strategy of the service organization aligns with a corporate cost leadership or niche strategy but may also be applied together with an innovation or quality leadership strategy.

Service activities, consequently, underline the requirement to generate a substantial financial contribution when not concentrated on decreasing cost, commonly leading to the establishment of a service organization with its own profit and loss

responsibility. This enables companies to measure the service businesses' profitability and to steer it accordingly.

A company's willingness for resource investment depends on the corporate strategy. An innovation or quality leadership strategy could result in establishing a significant service organization that still fosters financial sustainability. Contrary, manufacturers pursuing a cost leadership strategy might not want to invest heavily as they focus on using industrial services to reduce operative or product costs.

4 Managerial Implications

Defining a service strategy should be executed with care based on various information coming from the corporate strategy and multiple analyses. We advise companies and especially service heads not to concentrate only on their domain but align the functional-level strategy with corporate objectives and directions. Therefore, it is key to start with deciding upon the main goals of the service business, which guide the contribution to the superordinate corporate strategy. Continuing with formulating each dimension of the service strategy stepwise will then enable creating a coherent and coordinated picture of what the service business should stand for. A special focus should lie on the service portfolio discussion. After the objectives, the portfolio is one of the most crucial aspects since it contains declarations about the interdependencies with existing products and services.

To make it a reality, it is essential to communicate the strategy appropriately. For instance, product development should be aware of the importance of the service business, when the objective is to create substantial income with it. Eventually, they have to incorporate specificities into new product generations to leverage serviceability.

We suggest establishing a dedicated project team coping with the analyses, which occasionally intervenes with additional employees to achieve a holistic evaluation. External support can also help to shape and sharpen the service strategy with a neutral perspective, often reaching higher efficiency and visibility among the employees.

5 Summary

Deducted from the vision and mission of a manufacturing company, in alignment with its corporate strategy, the service strategy signalizes what the service business should accomplish. The service strategy might foster product sales if the company decides to concentrate on the product business in the future. Essentially, the corporate strategy dictates the role of the service business, and the service strategy demonstrates how to realize it.

We provided insights into the dimensions of the service strategy and how to receive the necessary information culminating in a formulated strategy. While three generic strategic directions exist, manufacturing companies should follow the

presented approach and create an individual service strategy suiting their specific contingencies.

Once the service strategy has been decided, it guides further management endeavors, such as structural or processual adaptations. As we already indicated in Fig. 2, structure follows strategy (Chandler, 1962)—so it is in the book at hand.

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Organizational Structure

Philipp Osterrieder

The British commanders were highly skilled professionals who affected the amateur style of country gentlemen. They banded with one another as old boys but were exquisitely sensitive to rank and privilege. Cornwallis arrogated the major decisions entirely to himself and rejected contrary advice from his officers. The Americans improvised a different system of command. It was forced upon them by the diversity of cultures in the country, by the pluralism of elites, by a more open polity, by a less stratified society, and especially by expanding ideas of liberty and freedom. The man at the center was George Washington. From much hard-won experience in American politics and war, he had learned to work closely with his subordinates. . . . Later he worked more skillfully by the construction of consensus. In that way he created a community of open discourse and a spirit of mutual forbearance.
D. H. Fischer (2004, p. 315) writing about the differences in the organization of the Continental and the British army in the American war of independence

Key Takeaways

- Discussing the organizational structure of the service business at manufacturing companies mostly concerns its integration or separation.
- The majority of manufacturers favor separation for traditional, physical services.

P. Osterrieder (✉)
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: philipp.osterrieder@gmx.net

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- Providing smart services, however, implies the collaboration of formerly highly independent functions, leading to a need for restructuring the current organizational design.
- Since companies are unique and general design guidelines nearly impossible to provide, we developed a typology of eight different configuration possibilities.
- Manufacturers can systematically use the typology, presented below, to find a feasible option depending on its particular contingencies.

Discussing the organizational structure of a company naturally follows the debate about its strategy. The quote above demonstrates the need for a fit of an organization not only with strategy but also with culture and the impact an organization can have on actions and outcomes. As we indicated in Fig. 2 in Chap. "Service Strategy", the formulated service strategy acts upon the organizational design and often leads to its rearrangement. Both practitioners and scholars agree that it is important to arrange the organization in a way that supports the effective execution of the defined strategy. More specifically, an organizational configuration suiting the current situation of a company fosters success (Hax & Majluf, 1983).

As manufacturing companies need to show ambidextrous abilities in managing both the product and service business, they see themselves confronted with various barriers and challenges, which we discuss in the next paragraphs. Afterward, we provide insights into different structuring possibilities for the service organization and distinguish between configuring the physical and smart service business. We end with recommendations for practitioners and a summary concerning the organizational structure.

1 Barriers and Challenges

A manufacturing company that undertakes the first steps toward providing industrial services to its customers is not likely to adapt the organizational design right away. Maybe the company adds people to the organization every now and then or just qualifies existing personnel to deliver the first services.

Yet, as the company changes the way it does business, it must adapt its organizational structure sooner or later. One of the main reasons why manufacturing companies struggle to meet the expected financial returns when ramping up the service business was found to be an inappropriate organizational design (Gebauer, Fleisch, & Friedli, 2005). It is, therefore, a crucial activity to re-tighten the organizational structure to increase efficiency and effectiveness.

For manufacturing companies, the main challenge lies in uniting the divergent behavior of product- and service-oriented organizations. As pictured in Fig. 1, product-oriented companies are typically engineering-dominated, wherefore most activities take place, and the major share of the personnel is located backstage. Promoting and selling the product, besides nurturing the customer relationship, are less pronounced compared to research and development endeavors of the hardware.

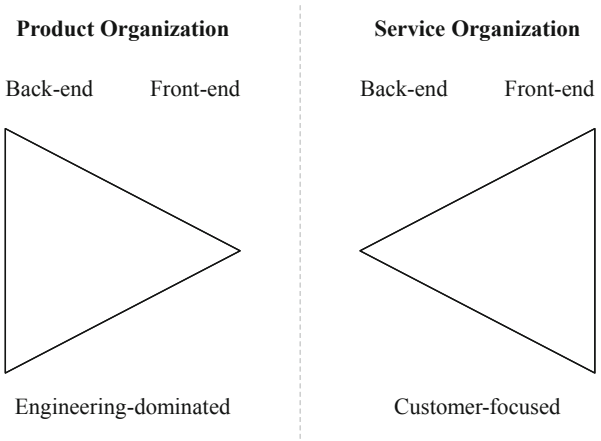

Fig. 1 Simplified illustration of employee distribution at typical product and service companies. Own illustration

For traditional service companies, it is exactly the opposite. Backstage tasks fall far behind, while the focus lies on customer-centered value creation.

To illustrate the main difference between a product- and a service-oriented organization, namely, the shift of the companies' focus, consider the following two examples.

Sefar is one of the world-leading manufacturers of filters for various industrial applications. The company attained such a high reputation due to the superior quality that most car OEMs explicitly include Sefar filters in their specifications for suppliers. Consequently, Sefar concentrates most of its resources on developing and producing the filtration solutions (i.e., on the backstage activities).

Contrarily, any consulting company (imagine the Boston Consulting Group, for instance) will not be successful when they try to sell pure method descriptions. They only create value for their customers when they cater to the customers' problems on-site. Hence, customer-facing activities are much more important than they are for pure product manufacturers.

Strategically offering services means uniting the divergent behavior of product- and service-oriented organizations. Simply combining the two triangles (see Fig. 2) is, however, not the right approach. Establishing a massive service organization next to the existing product business is unlikely to be a reasonable tactic and potentially undermines financial targets. Both aspects need to be intertwined in a way that the organizational design results in a mighty but lean constellation.

Manufacturing companies need to find a feasible version based on their contingencies, in strong alignment with the underlying service strategy, and concerning potential influences from make-or-buy decisions. Moreover, opting for a new organizational configuration leads to further implications, predominantly affecting current, as well as new, processes and roles.

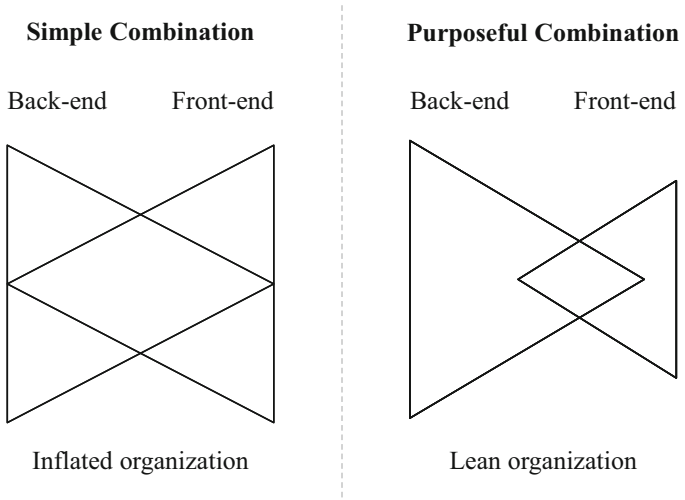

Fig. 2 Simplified illustration of a combined product and service organization. Own illustration

2 Structuring for Success

Introducing industrial services means, in most cases, that a manufacturing company first starts to offer physical services before advancing toward smart services. Correspondingly, the organizational structure may evolve in parallel to the servitization journey of the company. While dominant perspectives on the organizational design of the physical service business exist, companies may conceive different alternatives when providing smart services. Hence, we first present structuring possibilities in the first stage of the servitization journey before discussing recent insights in the era of smart services.

2.1 Organizing the Physical Services Business

About 15 years ago, discussing the organizational integration of the service business in the process of servitization gained more and more interest among scholars. Manufacturing companies reflected the need for clarification as they struggled to get the service business on track. At that time, two dominant perspectives on the organizational structure emerged, which are still present today.

We demonstrated that the service organization commonly works differently than the product organization, wherefore most experts tended to suggest manufacturing companies the separation of the service business (cf. Oliva & Kallenberg, 2003). Gebauer et al. (2005) endorse this position since they discovered a separate service organization would increase its performance and counteract the service paradox.

Separation does not imply the externalization of the service business in this case. Instead, it describes the organizational differentiation between the product- and engineering-dominated part of the company with the service- and customer-dominated part. A dedicated service business unit eases the development of a service mindset and comes along with higher measurability and accountability in terms of profit and loss responsibility (Turunen & Toivonen, 2011).

However, to provide compelling value propositions consisting of products and services, the second view focuses on the integration of the service business (Neu & Brown, 2005, 2008). The rationale behind the integration perspective is that companies typically offer new services to existing customers; thus, the companies' products and services jointly contribute to the customer experience. Consequently, manufacturing companies should bring product and service teams closely together to better serve customer needs and provide real solutions (Biege, Lay, & Buschak, 2012).

The functional integration of the service business may be reached by establishing product and market-facing teams within each division. Transparency about the effect of the service business can, therefore, be an issue. When the company is not able to measure this effect, which occurs frequently, companies need to find other steering mechanisms or key performance indicators.

Both constellations describe two extremes located on the poles of the integration-to-separation continuum, each comprising certain advantages and drawbacks. Notably, the differentiation between those two alternatives increasingly blurred over the last decade. While most manufacturers followed the suggestion of a separate service organization, scholars question when separation is really necessary (Fliess & Lexutt, 2017). Most recently, several authors concluded that separation might not always be the best solution as it does not guarantee success (Raddats, Kowalkowski, Benedettini, Burton, & Gebauer, 2019; Turunen & Toivonen, 2011). Nevertheless, they feel that separating the service business eases its ramp-up, and companies will find a way to structure the organization with progressing maturity.

From a practical point of view, we experienced that most manufacturing companies established a separate service organization. Even though separation complicates the company-wide diffusion of a service mindset, it enables better controllability through its own profit and loss responsibility.

When a company offers traditional, physical services, it seems to be a reasonable choice to separate the service business. Service operations commonly succeed the product sales, so it is for service and product development. As service- and product-related activities are decoupled to a large extent, organizational separation can be a logical choice. However, the possible conflicts between the product and the service business should also, in this case, not be underestimated, especially if it comes to profit. Without a service strategy that is derived from the overall corporate strategy (see Chap. "Service Strategy"), these conflicts could easily escalate.

2.2 Organizing the Smart Services Business

Moving toward smart services even creates more challenges than providing physical services. Distinguishing between product- and service-related activities is less clear, as smart services are closer to products, build on data from the companies' products or third sources, and contain a software component on top of that.

When manufacturing companies decide to provide smart services, it entails a more invasive reaction on the organizational configuration than introducing physical services. But why is this, in general, the case? Consider the following example.

When the machine tool manufacturer, on which we elaborated before, decided to provide physical services, the CEO made clear that the services should support product sales by increasing product availability, in turn, raising product attractiveness. The CEO figured out that the company can leverage service efficiency and effectiveness by consolidating the required competencies aside from the regular product business. Consequently, the service department is responsible for developing new installation procedures, repair, and maintenance schemes, as well as training plans, once their colleagues developed a new product generation. As the interaction between these two divisions is limited to very few touchpoints mostly concerning product specifications, the CEO does not feel the need to rethink the current organizational setup.

Later, after the company introduced the remote monitoring and dashboard service to the customers, service managers anticipate the potential and need for providing a predictive maintenance service. So far, the CEO partnered with an external software company to develop the remote monitoring service, but now understands that it could be beneficial for the future to leverage the knowledge for smart service development in-house. The predictive maintenance service consists of a software program that uses machine tool data to flag potential failures after reaching or surpassing a predefined threshold. Consequently, the service department has to define the business concept behind the new offer, IT or a dedicated software unit needs to build the program, and the product organization must ensure that the right data, with the right velocity, is transmitted accordingly.

Developing this service leads to the collaboration of at least three different departments with far more touchpoints than they used to have. It demonstrates that the CEO has to react to the new circumstances by restructuring the company.

Based on the complexity involved, companies reveal a growing interest in receiving guidelines on how to adapt the organization due to the emergence of new digital technologies and smart services.

We asked manufacturing companies during a benchmarking study how they think the optimal organizational configuration looks like and let them select one answer among five different options (staff function, decentralized, project/lead team, separated functional unit, and integrated functional unit). Forty-two percent think that separation is the optimal choice, while 32% opt for an integrated structure. With the residual 26% selecting one of the other options, it becomes obvious that not a single optimal configuration exists. It may be true that some companies are just wrong in what they think is the best structure, but a plethora of extant literature

suggests similarly that organizations are unique scaffoldings adapted to the individual contingencies of each company. Giving specific guidelines on how to adjust each organizational structure is, thus, tempting, but nearly impossible without getting too abstract.

Nevertheless, recent research in close collaboration with industry allowed us to derive a typology of eight different organizational configurations with a focus on the integration of the smart service business at manufacturing companies. These eight types are quasi-fictional representations of real-world organizations, meaning that each type accentuates particular traits to increase differentiation but is unlikely to exist in practice in its displayed form. However, manufacturing companies can examine the developed typology to find a role model for their future structure, or just to get inspiration for how to re-arrange the current design. Deciding for a specific type entails its customization to the manufacturers' context, wherefore it is essential to follow a selection process with care and transparency.

But first, we characterize the eight structuring possibilities illustrated in Fig. 3.

2.2.1 Hub & Spoke

The first type accentuates the collaboration between a central digital unit and the smart service teams within each division. The digital unit may be an independent department with a focus on digital technologies, technology-centered research, and all competencies pertaining to gathering, handling, or processing data. It could be consolidated with the corporate IT, or established next to it. On the other side, the market-oriented divisions have sovereignty and responsibility for the service business, while the digital unit supports the technological aspect of service development.

Particularly manufacturing companies that tend to be active in diverse product markets, where the specificities of each product are complicated to scale throughout the entire portfolio, might opt for industrial service teams close to the product business. In combination with a central digital unit, uniformity in terms of platforms, tools, and IT infrastructure can be ensured to prevent undesired redundancies.

2.2.2 Front-End Convergence

The main focus of the second type lies in the dominant sales department. Here, the functional arrangement of the company culminates in the mighty sales unit. The idea behind this type is that no matter which product, physical, or smart service each department develops, the ultimate goal is to satisfy the needs of the customer. Therefore, the sales force needs to have all the munition the company may offer when discussing the current situation with customers. Perhaps the best solution is to offer a leasing contract for expensive machinery or a combination of physical and smart services to prolong the usable life of existing equipment. In any case, customer-centricity is the magic word for companies that represent this structure.

Concerning the smart service business, it can be part of the industrial service unit or erected as an independent department next to the product and physical service business. Depending on the compatibility among the industrial service portfolio, it could be reasonable to unite or separate the different service businesses.

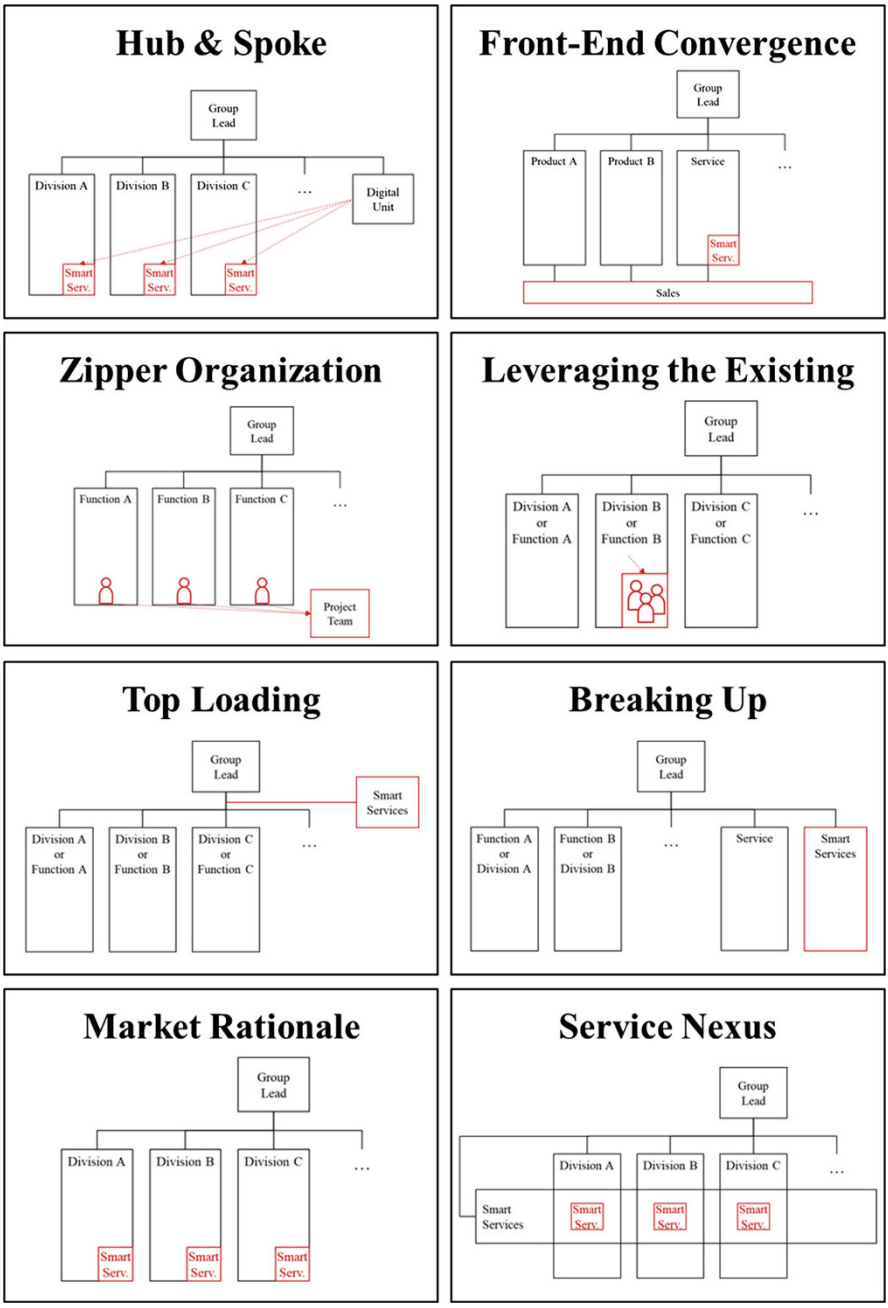

Fig. 3 Graphical representation of the derived types of organizational designs. Own illustration

2.2.3 Zipper Organization

When manufacturing companies begin serving existing customers with new smart services, they frequently opt for a project organization. Here, we describe a version of a project organization where the team consists of knowledgeable employees from different functions (including product development, IT/software, and service). These can be representatives for their functions cooperating to build a new smart service, while most of the actual work is executed within each unit. Or, the project team involves temporarily delegated employees comprising all necessary competencies for smart service development.

In both cases, the long-term sustainability of this configuration is questionable. The advantages lie instead in fast and agile working conditions paired with its easy and resource-poor implementation, when the responsibilities are clearly defined and communicated.

In practice, we often realized that manufacturing companies try to settle the uncertainty about the potential and consequences of introducing smart services within project teams. The manufacturer then decides to transition to a more stable organizational structure once it specified the strategic direction and objectives of the service business.

2.2.4 Leveraging the Existing

Leveraging the Existing mirrors a highly integrated organizational structure in contrast to *Breaking Up* (see below). Companies that choose to integrate the smart service business typically assign the additional tasks to units, teams, or individuals who have a strong background in related fields, such as software or service. Often, they do so because the new smart services align with the existing business to a great extent, or the company feels that it has the right competencies in place. Sometimes it can even have been organically grown within one distinct unit, when they started to advance into the field of smart services on their own initiative.

Manufacturers can use this organizational structure to build coherent and sound value propositions involving products, physical, and smart services. The closeness to each other helps shape complementing and supporting strategies. However, measuring the effectiveness of the newly introduced smart service on performance enhancements is difficult. Steering indicators could focus on values such as recurring revenue, the number of service contracts sold, or the project backlog in terms of secured service months. But only when the business and pricing model of the smart service allows to measure these values, it could provide an option to indicate the success of selling the service, as well as its contribution to the overall revenue.

2.2.5 Top Loading

Centralized decision-making typically characterizes manufacturing companies that select a *Top Loading* configuration. Here, the smart service unit mirrors a staff position with a short distance to the top management. The business side of service development takes place at this prominent position to enable fast and flexible decision-making besides highlighting the importance of the new business to the employees.

However, other divisions or functions are responsible for the technological development of the smart services, which may lead to bottlenecks, as the regular product development departments access the same resources.

Long-term sustainability could be an issue for this type. Yet, it reflects a good starting configuration due to a relatively cost-efficient establishment of the smart service business.

2.2.6 Breaking Up

The fourth type is the closest representation of a separate service organization. Figure 3 illustrates the separation of the smart service business on the divisional level, while it could also be done at the unit or team level. It surely allows good measurability and accountability in terms of financial figures (e.g., profit and loss) but requires intensive resources for its setup. Often the acquisition of new talents is part of erecting a separate service organization, and long-term sustainability should not be an issue.

However, a manufacturing company needs to balance the advantages and drawbacks of going for a separate smart or industrial service business in general. Following this approach leads to the investment of vast financial and human resources with limited reorganization flexibility in the future. Once the company ramped-up such an organization, it may contribute to the overall performance significantly, but fast-changing market or environmental conditions may be absorbed less easily.

In practice, we experienced that separating the smart service business at least for some time is repeatedly the only choice for a manufacturing company since the new business is substantially different from the existing product and service portfolio. It naturally entails the need for novel processes, approaches, and personnel in a detached organizational form.

2.2.7 Market Rationale

When companies engage in diverse markets with diverse products, they often mirror a divisional base structure. These divisions then have sovereignty about what to offer to whom.

Consider Liebherr. The company is active in branches ranging from mining and earthmoving technology to refrigerators and hotels. Accordingly, the specific requirements for a remote monitoring service and the characteristics of typical customers can vary a lot. Establishing a central industrial service unit is, therefore, at least disputable.

Consequently, the *Market Rationale* configuration suggests that these companies have individual service units within each division. There might be project groups or committees that meet every quarter to exchange ideas, strategies, and standards. But in general, the division determines the entire service, including its development, sales, and delivery.

While companies usually show a good fit for the smart service aiming at the needs of the customers in the interplay with the respective products within their division, the main challenges concern the redundancy and standardization among the entire

company. Platforms, tools, or software that are used by one division might not be used by another. In the worst case, divisions have overlapping customer groups and do not offer compatible service approaches, or even do not know about their colleagues, who just sold a similar service one month before.

Transitioning to the *Hub & Spoke* type, or something similar, including a central unit overseeing these topics, could be a possibility to relieve these problems, whereas giving up tasks and responsibilities is often not associated with the strengths of division heads.

2.2.8 Service Nexus

The last type is the sole representative of a matrix organization. While other configurations can be adjusted or superpositioned to result in a similar design, *Service Nexus* describes an example of a configuration where a smart service function overlaps with the market- or product-oriented divisions.

The advantages are obviously that the service unit can coordinate the development centrally, while the knowledge from each division provides valuable input to increase its suitability for and compatibility with the specific products and customers. This configuration helps to ensure standardization among the platforms, tools, and software, besides offering the opportunity to scale developed solutions at one division throughout the adjacent departments.

However, frictionless operations may be an issue as its implementation can be difficult. Division heads could fight for scarce resources, wherefore this type is prone to political games. Yet, if manufacturing companies install a nearly seamless working version of this type, long-term sustainability is not a problem.

We showed that each type has certain advantages and shortcomings. Various attributes characterize the configurations, on which we elaborated briefly during their descriptions. When a company feels the need to reorganize its current structure, it has to meticulously assess which design might be suited best depending on its contingencies.

As we already stated in the introduction of the typology, selecting a configuration is one thing, but it entails the customization and implementation of the new structure into the firm.

Cycling back to the example of the machine tool manufacturer presented before, we remember that it partnered with an external software company to provide the remote monitoring service, while the company leveraged the skills of its employees to develop the dashboard service. Moreover, the CEO declared preferring to build up the knowledge required for the predictive maintenance service internally.

Browsing through the available types, we could propose multiple options. Assuming that the company offers a wide portfolio of machine tools, but nothing greatly different than that, to customers with similar requirements, there is no need for strong market orientation. As we introduced the manufacturer as a mid-sized company, we suggest a separate service organization. The service organization splits into one unit handling physical services and a team addressing the smart service business. Technological developments in terms of software, sensors, and data should be clustered into another separate organizational entity adjacent to the product and

service business. Each competence center can nurture its skills individually, while a project team or steering committee ensures the alignment of all activities toward the mutual goal of developing the predictive maintenance service. Establishing the committee is key to preventing solo efforts, but may cause discussions and dissatisfaction among important players in the game.

Restructuring measures are often highly political endeavors, which may lead to tough decisions. As communication and transparency are crucial in these situations, we focused on logical arguments for and against potential configurations.

3 Managerial Implications

Manufacturing companies need to accommodate the right organizational structure when introducing industrial services. Depending on the service strategy, the kind of offered services, and other contingency factors, the typology can be used to inspire the reorganization process. While we developed the typology with special attention to new, smart services, the specified configurations are still valid options for companies that are at the beginning of their servitization journey.

When selecting a preferred type, companies need to meticulously address the associated advantages and shortcomings, as well as customize the quasi-fictional representations to the present contingencies. To systemize the selection process, we propose the following five steps adapted from Osterrieder (2020):

1. *Reduction of feasible solutions*
   The general composition of an organization relies on a functional, divisional, or matrix structure. We recommend reducing the solution space by eliminating those types, which are based on those two fundamental structures not similar to the one of the focal company. Yet, a manufacturing company that follows a divisional structure, for instance, can still deliberately choose to look into functional configurations to stimulate the reorganization process.
2. *Screening*
   During the screening phase, a closer examination of the potential configurations takes place. The focal manufacturing company should familiarize itself with the characteristics of each type by focusing on two things. First, the company can delineate the similarities between the potentially new designs and the actual organizational structure. Second, it may look into aspects opposing the current situation.
3. *Preselection of preferred types*
   The preselection of preferred solutions may come naturally or has to be discussed in depth—either way, a choice needs to take place at that point. When examining the available types, the company should ask: Which types would fit the current situation, the corporate strategy, and especially the service strategy the best?

   Here, we have to note that this exercise may be accomplished in a short amount of time to obtain the initial feedback and trigger discussions. However,

to build an organizational structure with long-term sustainability, we advise first to define a clear service strategy, if the company has not done so before.

4. *Prioritization of preferred types*
   The fourth step aims at finding a single solution that the company should implement afterward. In striving to transform the organization, we customarily want to choose an optimal configuration eliminating all shortcomings. However, all types have certain weaknesses that may or may not have dramatic effects on the focal company. It is therefore essential to delineate whether these drawbacks depict lower barriers a company can overcome or that may not have an impact on their business at all, and those that could turn into real roadblocks.

   The company should eliminate those types whose corresponding drawbacks require significant resources to overcome, leaving a more suitable type, considering the current capabilities and culture.

   Nevertheless, once the company discovers during the customization and implementation stage that the favored type evokes major roadblocks, it is possible to cycle through steps 3 and 4 iteratively.

   Additionally, it is worthwhile to note that the approach focused so far on the selection of one suitable type. But it is not limited to only a hybrid configuration of two (or more) types. It may even provide completely new insights, yet, those may come with increasing complexity.
5. *Customization and implementation*
   We learned before that customizing and implementing the selected type is a crucial step to make it a reality. Along with it will be various problems, discussions, and decisions, all of which have a highly individual nature. Offering further guidelines is, therefore, nearly impossible. Yet, we want to emphasize that the entire process needs to be managed with care, attention, and commitment, as introducing a new organizational structure implies multiple adjustments, including changing processes and roles.

4 Summary

Finding the right structure is vital for companies to drive performance, especially when an organization embarks on a transformational journey adding formerly unknown or unaddressed subjects to the existing business.

Manufacturing companies will have encountered organizational change before, but introducing services entails different capabilities and mindsets that oppose current approaches. Product organizations are generally engineering-dominated and technology-oriented. Contrarily, service organizations focus on the happiness of the customer and adopt a customer-centered development style. The clash between these two philosophies regularly concludes with a disadvantage for the service business, sometimes leading to the service paradox.

Concerning physical services, however, discussing the organizational design is not a new phenomenon. Scholars and practitioners have shown that primarily integrating or separating the service business can work depending on the individual

contingencies of the firm. While we found that separation is favored in many cases, it should be questioned in the light of new, smart services.

Providing smart services implies the collaboration of formerly highly independent functions, as we have seen before. Formulating direct guidelines to solve this chaos is, thus, complicated.

Essentially, we came up with a typology of eight different organizational configurations that describe feasible solutions for most manufacturing companies. These can be used during a restructuring process, which adheres to the five steps: reduction of feasible solutions, screening, preselection of preferred types, prioritization of preferred types, and customization and implementation.

Customizing the selected configuration is imperative and should not be underestimated. Succeeding implications concern core and enabling processes or activities, which we detail in the upcoming chapters.

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Service Innovation

Christoph K. W. Blum

Success is not final; failure is not fatal: it is the courage to continue that counts.
—Winston S. Churchill

Key Takeaways

- A systematic service innovation process increases the success of service offerings.
- A clear focus on the early innovation phase is necessary to identify meaningful service opportunities around traditional product applications.
- Customers have to be involved in the entire innovation process to ensure their satisfaction with the service offering.
- Required resources and capabilities to innovate and deploy new services have to be assessed within the manufacturer's and customer's organization to avoid expensive pitfalls.

Based on our St.Gallen Industrial Service Management Framework (cf. Chap. "Fundamentals of Industrial Service Management"), service innovation is one of the key disciplines manufacturing companies need to master to offer services successfully. Thus, this chapter sheds light on the evolution of service innovation at manufacturing companies. We will describe future pathways for how firms can perform service innovation in line with their corporate or service strategy. Relevant characteristics of a service will guide this chapter before we propose a universal guideline that supports practitioners to innovate fruitful services.

C. K. W. Blum (✉)
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland

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1 Pitfalls in Service Innovation

Due to the increasing commoditization of a leading firm's products, the top-level management decided to enhance their current service offerings. In parallel to the ongoing digitalization of factories and products, digital technologies can support customers and provide a benefit to future business outcomes. Consequently, customer care, as the department in charge, started to develop a smart service based on digital technologies. In the following, service specialists developed a prototype of a benchmarking service in cooperation with lead customers. The early development of the service progressed very favorably. All processes and technologies worked well together. Therefore, project managers decided to roll out the new service globally. However, this proved to be much more difficult than expected.

During the prototype's development, only resources from headquarters and the selected lead customers had been taken into account. Service developers expected no major differences when rolling it out to other customers and involving their subsidiaries. Nevertheless, reality demonstrated otherwise. The manufacturer's and customer's subsidiaries were not capable of offering and receiving the service, respectively, as their organizations were not prepared to perform the new tasks. Finally, the narrow development environment caused severe financial losses. First, conceptual adaptations had to be made, which delayed the final market launch and therefore were costly. Second, revenues fell short of expectations as sales activities had to be aborted until adaptations were completed.

A systematic service innovation process might have prevented this manufacturing company from experiencing these issues. Such a process guides service developers and considers necessary resources from an early stage. The following chapters elaborate on how this failure could have been prevented through an adequate service innovation approach.

2 Evolution of Service Innovation

In Chap. "Servitization of Manufacturing Companies," we saw that manufacturing companies have been transforming their offerings toward services for decades. Decreasing margins and shrinking differentiation between competing products drive this development. Consequently, it is of particular interest for manufacturing companies to analyze future business opportunities in services.

Manufacturing companies' offerings can be divided into three categories: products, services, and solutions. Products provide customers certain functions and features to run their business. Services add to this basic need as they further support customer operations. Solutions offer an even higher value to customers since they combine the value propositions of products and services. Due to the ongoing commoditization of products, services provide a more significant lever to increase a solution's value proposition compared to products. However, the traditional product business still dominates the business logic of manufacturing companies.

Therefore, a vast continuum of product-service combinations constitutes current offerings.

Today, manufacturing companies move on to develop not only physical but smart services. Traditional after-sales services are still part of the portfolio to support the present business model. Yet, the focus in business development evolved from developing physical toward smart services.

Manufacturing companies started to offer physical services aside from their traditional products to support customers in operating them (cf. Chap. "Servitization of Manufacturing Companies"). In this way, suppliers addressed explicitly articulated customer needs, which are still important during sales negotiations. However, all processes to design new offerings are consistently product-driven. Physical services were developed on an ad hoc basis whenever customer needs should be satisfied. Therefore, specific processes to innovate early physical services have been absent for a long time. However, some companies identified the need for a systematic service innovation process quite early (cf. Chap. "Fundamentals of Industrial Service Management").

The advent of digital technologies and software development initiated a further shift in the process landscape of manufacturing companies. Through this evolution, processes became more customer-centric and agile. In addition, such process designs ease the implementation of new processes to develop service offerings as they fulfill important prerequisites of service innovation. We experience that manufacturing companies are still in their infancy concerning the organizational restructuring that comes along with successful service transformation (cf. Chap. "Organizational Structure").

A historical lack of a manufacturer's capabilities in developing smart services is the basic issue for underperforming smart services. Disparate characteristics of products and services lead to the necessity of creating a new set of capabilities to innovate smart service offerings successfully. Today, manufacturing companies most often try to leverage their existing capabilities of product innovation to develop new smart services. Thus, they miss addressing unique characteristics that have to be taken into account during service development. For that reason, manufacturing companies have to build new capabilities embedded in a new service-specific innovation process. A cultural change would furthermore underpin manufacturers' aspirations to drive their service business. Relevant parts of the organization must foster the service mindset by proceeding from a strong focus on "only" developing high-class products to an organization-wide additional high-quality service culture.

Academia provided first insights on how manufacturing companies could improve their service innovation. For instance, in his seminal work, *The Theory of Economic Development*, Schumpeter (1934) emphasized the importance of gaining competitive advantage through the recombination of productive resources. He proposed five different possibilities for a company to achieve an improved market position: 1) introducing new products to the market, 2) applying new production approaches, 3) identifying new markets, 4) exploring new suppliers, and 5) organizing business activities differently. Those five dimensions refer to either the process to generate innovations or the outcome of potential innovations. In this

sense, two distinct areas of analysis are of particular interest regarding service innovation. First, the transformation of the offering as the innovation outcome forms a major research area, discussing issues along with the specific design of product-service offerings. Second, researchers focus on the organizational transformation of manufacturing companies sparked by the introduction of services.

Against this backdrop, the subsequent paragraphs concentrate on the organizational implications rather than on specific design options for new service offerings. We understand service innovation as the process of how to achieve a new service offering that meets the individual needs of a manufacturing company. Consequently, the following does not indicate what innovative service offerings manufacturing companies should aspire to as future innovation outcomes.

The service as the innovation outcome has to be clearly defined to develop services successfully. We elaborate on the peculiarities of services below before discussing what process should guide future service development.

3 Dimensions of Service Innovation's Outcome

A great variety exists on how to specify services. Initially, services have been considered to be intangible, heterogeneous, inseparable, and perishable (IHIP) (Cusumano, Kahl, & Suarez, 2015). IHIP characterizes basic services like repair or maintenance jobs.

In this case, the service is:

- **Intangible** as it has no physical appearance before the outcome becomes visible
- **Heterogeneous** because frontline employees, who deliver the service, have to adapt the service delivery process according to the unique boundary conditions of every repair or maintenance job
- **Inseparable**, since the provision of services leads to their simultaneous creation and consumption
- **Perishable** as no service can be pre-produced to prepare for future demand

The emerging digitalization of products and services blurs the differences between these categories (cf. Sect. 3). Smart services rely heavily on hardware as a source of data. Digitally enhanced products fuel these services with data from their sensors. Third-party data from other devices can enable valuable service features. For that reason, the software is a major part of smart services to generate value from the underlying data. We also recognize that supporting hardware devices enable smart service delivery, and therefore, smart services are becoming partly tangible, homogeneous, separable, and storable.

Additional classifications of services concentrate on the services' purpose. This mostly includes the relationship between products and services. In this sense, manufacturers can design services to support product operations or focus on improving customer operations through service provision (Mathieu, 2001). This view of services can be translated into three evolution stages. First, base services ensure

product delivery. Second, intermediate services support product operation. Third, advanced services increase the performance of the product or customer operations (Baines & Lightfoot, 2014). All these perspectives emphasize the importance of the service outcome (purpose).

The service outcome can be referred to as the improvement of customer operations as any kind of service (base to advanced) impacts customer operations. For instance, even a simple repair service of a machine tool manufacturer influences the operations of their customers. If the manufacturer has to exchange a worn part of the machine tool, employees from both sides have to interact several times. The first contact might be the customer's notification that the machine tool needs a repair service. From this point on, the manufacturer and the customer will cooperate by clarifying the reason why the machine stopped working until the invoicing at the end of the repair service. Each interaction is part of service delivery and customer operations. If the notification system of the manufacturer is complicated, the customer's employees lose a lot of time to inform the manufacturer that a repair service is needed. For this reason, the better the manufacturer designs each interaction, the better the customer's employees can follow the process. Another option for the customer would have been to execute the repair job on his own. In this case, the repair job relies completely on customer operations as he has to include every single step of the repair job into his own operating model. Consequently, the overarching goal of the service is to optimize customer operations. Nevertheless, the service outcome (e.g., the exchanged worn part) can only be achieved through the manufacturer's service delivery in cooperation with the customer. We, therefore, conclude that both the service outcome and the related service delivery process have to be the result of service innovation.

To accomplish this goal, the manufacturers have to design six dimensions during the development of a new industrial service illustrated in Fig. 1. We indicate that the configuration of each service depends on the specification of every single dimension.

In general, service offerings are defined through their value proposition and enablers. As discussed above, the optimization of customer operations is the main objective of the service. Figure 1 refers to this as Dimension 1. At the same time, the optimized customer operation is not the only part of a service's value proposition, albeit the most important one. The customer interface defines how the supplier interacts with its customers. In this dimension, it is key for suppliers to focus on designing a great customer experience. Regardless of how sophisticated and supportive a service might be, if the interface to the customer is not designed sufficiently, customers will refrain from using the service. On the one hand, the interaction could be in the digital space (e.g., through GUIs [Graphical User Interface]) of mobile apps or browser-based applications. On the other hand, there is a physical interface to customers in most cases as well. Every frontline employee deals with the customer in a certain way. Therefore, frontline employees should be trained to always strive for customer satisfaction. This goes beyond purely delivering the exchange of a worn part. It is more about the frontline employee interacting as a comprehensive service provider. Inter-firm processes build the foundation of the customer interface as the underlying dimension of the value proposition. The service

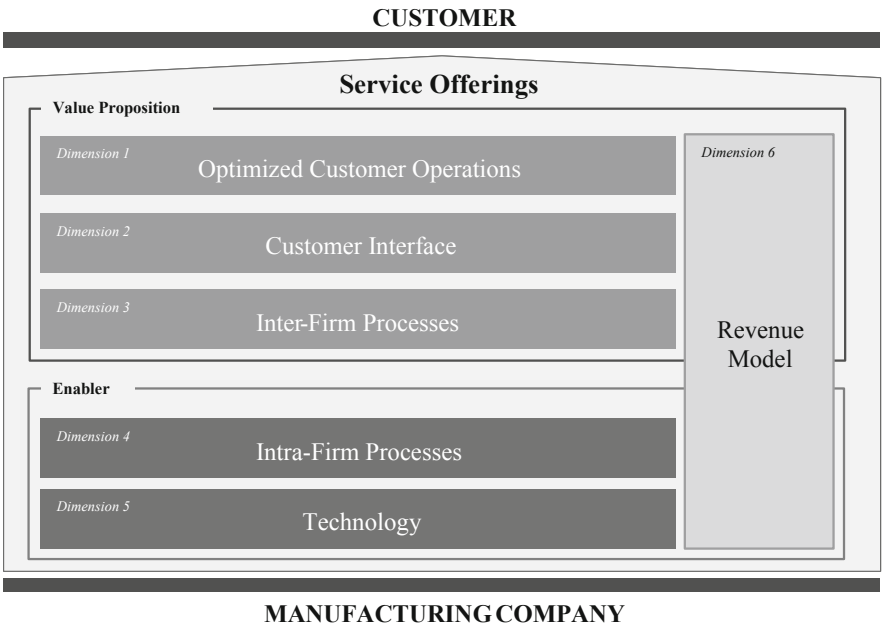

Fig. 1 Dimensions of a service. Own research

delivery process was considered as one single process. However, the aforementioned service delivery process is, by definition, split into two characteristics. Inter-firm processes define what is delivered from the supplier at the customer site. According to the example of exchanging the worn part, all activities of the frontline employee to execute this job at the customer site are part of inter-firm processes. In contrast, all opposing customer activities are designed in Dimension 1 (Optimized Customer Operations).

To offer the value proposition to customers, a great number of preparatory steps have to be accomplished before the actual service can be carried out. The two enablers, intra-firm processes and technology, facilitate a suitable value proposition to customers. Intra-firm processes include all activities suppliers have to perform with no visibility to their customers. In the example of repairing the machine tool, such activities would be preparing the van of the frontline employee with required tools and materials, as well as driving to the customer site. Finally, technology is a more complex dimension. Although the software is the core technology of smart services, hardware plays an important role as well. For physical services, the technological dimension is grounded in the installed base. The ongoing digitalization enhanced the installed base by software components and connectivity. Smart services build on these prerequisites as they apply software to leverage generated data of the installed base. Successful service suppliers include third-party hardware that delivers valuable data to create new or enhance existing service offerings. They also use additional hardware devices to support service delivery and its customers.

Finally, the revenue model completes the service, which cannot be unambiguously assigned to the value proposition or the enablers. It all depends on the receiving customer and the related market environment of the service. Even if the manufacturer designs the revenue model as part of the value proposition, customers could perceive it just as an enabler and vice versa. Nevertheless, the revenue model is a mission-critical part of the service offering that is mainly covered in the next chapter, focusing on service sales.

4 Dimensions of the Service Innovation Process

Continuing from the basic characteristics of a service, it is important to define the service innovation process that leads to a new service offering. Generally, a service development process ensures the successful composition of all treated dimensions. Manufacturing companies approach service development in various ways. Three different streams to design the service development process can be distinguished. All three approaches are grounded in the manufacturer's expertise in developing new products. In comparison to product development, service developers and researchers advocated for either the assimilation, demarcation, or synthesis perspective on service innovation (Witell, Snyder, Gustafsson, Fombelle, & Kristensson, 2016).

The assimilation approach postulates that services can be equally developed to products. For this reason, no adaptions to service innovation would be required to develop new services. This perspective focuses on the introduction of new technologies to the service business. Accordingly, new technologies should be the main impetus to innovate new services. Contrarily, the demarcation perspective calls for a completely new approach to innovating services. Representatives of the demarcation perspective argue that differing peculiarities of services compared to products have to be addressed through a unique development process. Finally, the synthesis perspective identifies the need for a unified innovation framework of services and products. As the continuum of product-service offerings is getting more and more interrelated, the development process of such offerings should address this trend in the same way.

Each of the three perspectives comes with advantages and disadvantages in innovating new services. The differences between services and products are crucial to answer the question of which perspective manufacturing companies should adopt. The comparison of services and products along the introduced dimensions of services exemplifies the different characteristics of both.

Overall, the innovation outcome of service innovation differs significantly from product innovation. While services highly depend on the interplay between the execution of processes and supporting technology, products mainly represent technology customers can apply to their business (cf. Fig. 2). Nevertheless, three dimensions complement a product: the customer interface, technology, and revenue model. At the same time, the characteristics of each dimension differ from the related service characteristics. From a product point of view, the customer interface is again split into a digital and physical component. Those two components are directly

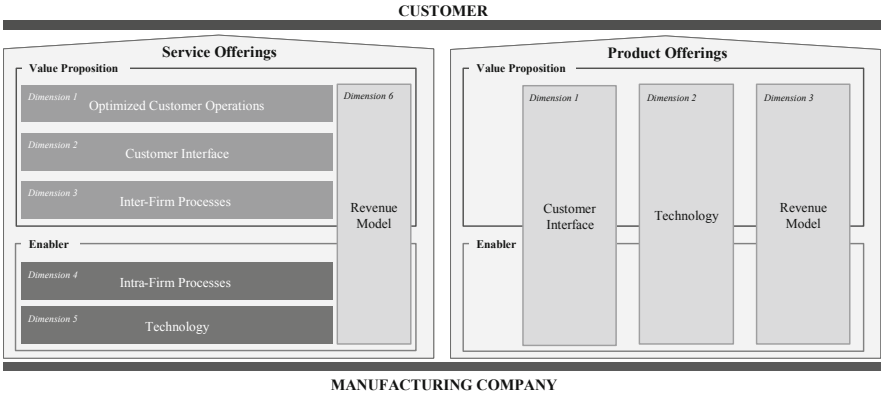

Fig. 2 Differences between services and products. Own research

linked to the technology dimension, in turn, also consisting of the software, as the digital component, and hardware, as the physical component. The design of a product's software and hardware primarily serves to enable the required product features. Product design (within Dimension 2) mostly defines how the customer interface is constructed. Therefore, the main objective of the product's customer interface is not to delight customers but to enable the usage of all relevant product features. The revenue model complements the product in the same way as it does with the service. Nevertheless, the revenue model of products acts as an enabler and as part of the value proposition.

Given that the characteristics of products and services differ strongly, it indicates that processes of product and service development have to differ as well. Therefore, the fundamental definition of processes provides further information on which process model fits best to service development. Generally, a process is defined as the transformation of input into a valued output (Hammer & Champy, 1993). Based on this definition, three different applications of service innovation would be possible. First, the same process could be applied to develop products and services as proposed by the assimilation perspective. Thus, each process could consider different inputs to suit the specific application. Since the characteristics of the output are significantly different, this approach is not expedient because the definition of intra- and inter-firm processes is not part of product development. For this reason, a major aspect of the service would not be developed. Second, the input could be the same for both product and service development. Then, the subsequent process would digest general input in a service- and product-specific way. This approach could lead to successful products and services as for each output, the specific characteristics are considered during the development process. According to the three types of designing service innovation (assimilation, demarcation, and synthesis), the second approach represents a fusion of the demarcation and synthesis perspective. The synthesis calls for the combination of service and product development. Using the same input for service and product development is the first step of

synthesizing both development approaches. Nevertheless, the entire process design is adapted to the peculiarities of the specific innovation outcome. Third, the demarcation perspective corresponds to the adaptation of the input, as well as the development process, to the specifics of the respective innovation outcome. However, product-service bundles are becoming more and more important. Therefore, the identification of customer needs as the development processes' input should be performed comprehensively. This procedure ensures that all customer needs are covered by the manufacturer's portfolio.

The overarching input of both development processes should be the same in the first place. Later on, managers should decide what customer needs will be addressed by services and products. Based on our industry projects, a synthesis perspective in the early innovation phase and a demarcation perspective in the subsequent innovation phase seem to be the most promising approaches to innovate new services successfully. The different characteristics between products and services and the absence of a sound service innovation approach call for further clarification on how to innovate new services. The following chapter describes in more detail how to proceed from identifying customer needs until the market launch of new services.

5 Applying Service Innovation Successfully

While academia tried to offer solutions in reorganizing the service innovation process, we experienced in practice that many manufacturers still struggle to innovate services successfully. Several try ad hoc approaches or strive to use product-driven innovation methods. But the results are often less satisfying. As a result, we developed a comprehensive service innovation process, together with manufacturing companies, based on recent insights from academia (Blum, Budde, & Friedli, 2019). Therefore, to overcome current product-driven innovation approaches, we propose three iterative cycles guiding manufacturing companies to innovate services successfully (cf. Fig. 3). The identification, conceptualization, and implementation

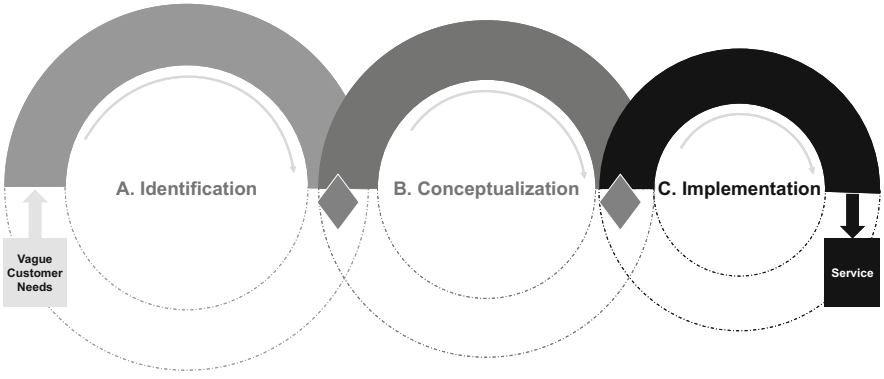

Fig. 3 Smart service innovation process. Own research

phases ensure the comprehensive development of all service dimensions. Using the proposed service innovation guideline to optimize existing service offerings leads to slightly different interpretations of the three cycles. Nevertheless, the three cycles are equally important for service optimization as it is for new service development.

A. Identification

The identification phase is about deriving new opportunities in the service business and to provide promising ideas of potential service offerings. The foundation of the smart service innovation process is vague customer needs. In the beginning, manufacturers typically have only rough insights on how they could support their customers better. The depth of information is often not sufficient due to misunderstandings and lack of cooperation on both sides (manufacturer and customer). Therefore, it is of great relevance to specify customer needs as early as possible throughout the innovation process. A long-term relationship between manufacturers and their customers, resulting in trust between both parties, eases information retrieval and increases the depth of information.

Generally, manufacturing companies have to consider four areas for new smart service impetuses. First, manufacturers should gain knowledge from their customers to identify their needs. Joint workshops, questionnaires, interviews, or focus groups support the identification of not prior articulated and latent customer needs. Through these methods, manufacturers may capture insights about, for example, improvement suggestions, problems with current products and services, or new industry requirements. Second, it is key for manufacturers to gain not only knowledge from customers but also about customers. Insights about customer operations on a process level are critical to assess and identify new industrial service opportunities. In the same way, the physical and virtual environment of the installed base is an appropriate starting point for this analysis. Third, market-wide technology scouting is important to support new service concepts with the best technological solution. Especially in this discipline, seeking cooperation with, for instance, other incumbent companies or start-ups could drive the technological development of the service business. Fourth, internal analyses concerning information about customers or internal improvements complement the quest for new business opportunities in services.

Once all information has been converged to derive new services, the knowledge should be stored to share within the manufacturer's organization. Often, knowledge exists within one's organization but is not accessible throughout it. Overall, an internal feedback and communication system eases the consolidation of knowledge about innovation impetuses. Therefore, manufacturing companies have to assess whether their internal feedback and communication system works properly. On the one hand, manufacturers can ensure information transfer via an open-minded personnel culture and close interactions between their employees. On the other hand, technology can support the internal feedback and communication process to assure that relevant stakeholders are using crucial and valuable information. Nevertheless, it depends on the characteristics of the manufacturer's organization which approach might be the most appropriate. In every scenario, gathered knowledge needs to be

tangible so that others can process it. Formal documentation, like reports, transcripts, or recordings, besides visualization techniques, support knowledge storage, transfer, and the interpretation of gathered insights. Nevertheless, knowledge sharing comes with the risk of overloading colleagues with too much input at this stage. Therefore, aggregating the relevant information is important to prepare the next innovation steps.

Based on the captured knowledge, business developers can derive initial ideas on how to improve existing services or which new service offerings might be promising. Sketches, storyboards, or rough prototypes enable the communication of those ideas. It is essential to build a basic prototype of every valuable idea. Otherwise, the characteristics of each idea cannot be communicated among relevant stakeholders. Peer feedback or a cognitive walkthrough challenges these ideas internally or with the customer. Drafting a business model complements the initial idea generation and prototypes. At this point, the evaluation of the fit with the current business model of the manufacturer is crucial to ensure the viability of future services. Nevertheless, subsequent feasibility studies are a precondition to ensure technical, financial, and legal realizability.

Within the early innovation phase, the most important challenge is to prove an added value of the derived service ideas for the manufacturer and its customers. Top management of the manufacturer mostly claims for tangible evidence that a promoted idea is worth pursuing. Project applications are a common tool to comply with top management's request to demonstrate added value during the product development process. Since the characteristics of services differ significantly from those of products, existing project application forms are typically not suited to assess the potential value of future services. For this reason, manufacturing companies have to apply new assessment procedures within service innovation. However, universally valid methods to assess the value of service ideas do not yet exist. Thus, every manufacturer has to develop its own approach to cope with this issue. A good strategy to address this challenge is to evaluate early prototypes in terms of expected business outcome and development costs. Virtual or physical tests at the customer site and internal cost estimations of all stakeholders shed light on the cost-benefit ratio. Those estimates have to be sufficient to decide the development of new services. The procedures illustrate that traditional governance systems are no longer applicable to manage service innovation. Decision-making in service innovation is rather a continuous evaluation of the project than applying predefined assessments. Nevertheless, managers have to limit the number of initiatives to allocate the firm's resources purposefully. A first gate at the end of the identification phase ensures that only the most promising ideas will be developed further.

B. Conceptualization

Service ideas will reach the conceptualization phase after they have initially proven potential value for the customer and the manufacturer. Early prototypes indicate how service developers could define the six dimensions of a service. However, each of the six dimensions subsequently has to be clearly defined as the early prototypes only roughly considers these dimensions. First of all, the value proposition has to be

precisely defined for every stakeholder. In particular, the optimized customer operation has to be established before all subsequent dimensions can be described. The optimized customer operation leads directly to a new process the customers have to follow. The process can be modeled using the business process modeling (BPM) technique to define the actions of all involved stakeholders on a technical level (Lindsay, Downs, & Lunn, 2003). Based on the BPM model, customer operations can be further detailed and designed. At the same time, this model acts as the core element to derive all underlying dimensions of the service and to continuously update the service prototype. The prototype acts as a constant means to communicate the service idea. Therefore, it displays all the relevant features of the service without being too specific.

To design the processes of the service, developers have to derive the touchpoints between the manufacturer and the customer from the BPM model. Based on these touchpoints, the *service blueprint* combines all process steps that have to be executed by the manufacturer during service delivery, including inter-firm and intra-firm processes (Bitner, Ostrom, & Morgan, 2008). Within one process flowchart, all process steps are integrated, following almost the same logic as our definition of a service. The service blueprint distinguishes between the manufacturer's process steps that are visible to the customer and those that are invisible to customers. Additionally, the service blueprint classifies supporting process steps of the manufacturer as a third category. This tool is well suited to define the process steps of a service in detail. Developers can map not only physical actions but also digital interactions and process steps. However, the service blueprint only contains activities that have to be executed, not the exact interfaces between the manufacturer and customer. We propose that customer experience designers have to add to the service blueprint the detailed design of digital and physical interfaces. By doing so, developers should cater for the four key values of successful customer experience design (Hollyoake, 2009). First, integrity is about a strong relationship between the manufacturer and its customers. Customers should hardly find this relationship anywhere else. Second, customers have to trust their manufacturers to support them as much as possible, rather than putting profit first. Third, manufacturers and customers should be aware of their interdependence as their business success is directly interrelated. Fourth, customers and manufacturers should freely share their needs and insights instead of hiding relevant information from one another.

Finally, the technology development addresses all requirements the process models and the customer experience design determined. Often, this phase is all about software and, to a lesser extent, hardware development. As manufacturing companies are more experienced in developing software and hardware, this phase does not strongly differ from product development, besides the emphasis on agile working techniques (Evangelista, 2000). After most of the development work, a proof of concept confirms the technical feasibility of the service. Once the technical feasibility is proven, the customer value assessment builds the foundation for the next major decision. Manufacturers have to involve their customers in both the proof of concept and proof of customer value. Their feedback on the prototype is essential

for the manufacturer's decision to proceed with the developed service or to abort it before market introduction. At this point, customer involvement is much more intensive compared to product development, as only customers themselves can confirm their satisfaction with the intangible service.

C. Implementation

Service prototypes that have proven their value to all stakeholders are almost ready for the market launch. However, they still have to meet some preconditions. After the proof of customer value, manufacturers know which part of the service is most valuable for their customers. Therefore, the service prototype can be divided into a minimum viable service (MVS) and a holistic service offering. The MVS is defined as a reduced set of service features based on the holistic service offering. Nevertheless, this reduced set of service features needs to satisfy the customer with its basic performance. The MVS is the starting point to launch the new service to the market. Before the manufacturer introduces the service to a broader customer base, the viability according to the required resources has to be proven once again. So far, the feasibility studies were conducted within the manufacturer's development environment or in close cooperation with individual customers. Therefore, the developers cannot guarantee that the whole organization of the manufacturer and all targeted customers can deliver and receive the service. For that reason, technical feasibility and required human resources capabilities have to be assessed globally. The market launch can only begin thereafter.

Along with the conceptualization phase comes the definition of the revenue model, which has been introduced before. The revenue model, among other essential topics to sell the final service, is presented in the upcoming chapter. However, we want to note at this point that market introduction, including the first learnings, has at least to be in parallel with the definition of the sales strategy. Even though the book at hand covers these two topics sequentially, realistically, it would be inefficient and ineffective to do so. Instead, both teams have to collaborate and design the service characteristics and the way to sell it.

Manufacturing companies can leverage their experience in introducing new products for the market launch of new services. However, they have to emphasize the comprehensive knowledge transfer within their organization. All involved employees need intensive training on what the value of the new service is and how the new service will be delivered to customers. Manufacturers should allow sufficient time for this training as it is crucial for the success of the service. Additionally, manufacturers need to decide whether their new service should be introduced to the market together with new products or independently; the bundling and portfolio discussion is not yet part of the service innovation process. Once all preparations are finished, manufacturers should conduct a limited market launch first before they introduce the new service to the whole market. By doing so, they have again the chance to learn more about the best configuration of the service. The characteristics of the service enable manufacturers to adapt even core processes at such a late stage of the development process without losing too much time and resources. Nevertheless, software or hardware adaptations should not occur at this

stage. Finally, the service should be rolled out to the entire market. From this stage on, the implementation phase of service innovation merges with the identification phase of future services and therefore provides future improvements of the current service offerings or the development of entirely new services.

6 Managerial Implications

The introduced guideline represents a general approach to innovate services successfully. However, the three cycles of identification, conceptualization, and implementation mainly provide a theoretical framework of service innovation. Practitioners have to adapt all tasks and activities described above to their specific business context. By doing so, the current configuration of one's organization has a major influence on how service innovation should be performed most effectively and efficiently.

Practitioners should consider four realms in particular when implementing a formalized service innovation process. First, manufacturers should design their own content of all process steps based on the three cycles. Defining specific tasks within each process step contributes to a suitable adaptation to the unique business context. Furthermore, the definition of process interfaces to the surrounding process landscape drives the specific determination of service innovation. Moreover, applying interfaces between service innovation and product innovation is key to the success of new services. Not only should individual process steps be defined according to the manufacturer's needs but also their composition to process sections that end with a decision point. Depending on the corporate culture of the firm, managers might want to be involved to a greater or lesser extent in decision-making along the service innovation process. Second, suitable tools and methods ease the execution of each process step as conceptional definitions of process steps are hard to follow for employees. Thus, tools (e.g., manuals, forms, templates, software, etc.) guide employees through each step and therefore enable the sufficient implementation of the defined process. Third, the purpose of the service innovation process and their related tools and methods is to serve people to organize their work. Therefore, managers have to assign employees, respectively, role profiles to each process step. Fourth, creating an organizational structure in which the role profiles are properly allocated enables successful service innovation (cf. Chap. "Organizational Structure").

Although we proposed the positive effects of formalizing service innovation comprehensively, manufacturers should strive for continuous adaptation of their innovation activities. The ongoing evolution of market requirements calls for dynamic adjustments of the manufacturer's organization.

Finally, formalization ensures the successful execution of service innovation on the one hand. On the other hand, formalized processes should allow for constant process advancement to meet future market needs as well as today's requirements.

7 Summary

The long history of manufacturing companies in innovating hardware products shapes their business logic until today. Changing market requirements and the rise of digital technologies urge the need for new service offerings along with their traditional product portfolio. To adapt to these changes, successful service innovation becomes vital for future business success. However, service innovation requires a new skill set compared to product innovation. As the manufacturer's business logic remains product-driven, their capabilities to innovate new services are still insufficient. For this reason, we provided insights into how practitioners could approach service innovation successfully. We, therefore, discussed the service innovation outcome based on six constituting dimensions. The initial focus on service innovation's result enables the efficient development of new services via three iterative cycles. Each cycle ends with a decision point to ensure sufficient allocation of the firm's resources. Finally, practitioners should identify which factors influence service innovation based on their specific business context to implement a formalized service innovation process tailored to their needs.

Formalizing service innovation is a good starting point to increase the success of future services. This chapter introduced the importance of the service's revenue model in general. The following chapter dives into specific revenue model characteristics and its fruitful design as it is another crucial element of successful service offers.

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Service Sales

Moritz Classen

You have to do your own growing no matter how tall your grandfather was.
—Abraham Lincoln

Key Takeaways

- Manufacturing companies are well advised to invest in service sales capability development to harness services' potential for long-term firm profitability.
- New service offerings require a dedicated market strategy that streamlines design choices for all subsequent market levers, notably bundling, revenue models, pricing, and sales channels.
- Market levers can only be pulled when an appropriate organizational backbone is in place.
- The particular characteristics of smart services call for new sales processes and roles that are complemented by a revamp of governance systems.

Commercializing industrial services requires a symbiosis of innovation and sales capabilities. The chapter "Service Innovation," highlighted the importance of formalizing the innovation process to turn vague customer needs into service products. Yet, for a market launch to be successful, manufacturers also need to have appropriate sales capabilities in place. This chapter exposes some of the challenges manufacturers face when selling services. The St.Gallen Industrial Service Sales Framework introduced in this chapter puts forward a set of levers manufacturers can pull to sell industrial services successfully.

M. Classen (✉)
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: moritz.classen@gmail.com

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1 A Story of Failure in Service Sales

Being at the technological forefront of service innovation does not guarantee commercial success. A Swiss manufacturer paved the way in its industry by offering a remote monitoring service for the installed base. The company became known beyond industry borders as a pioneer for smart service innovation in industrial applications. However, the commercial reality was different. Even 10 years after the launch, the market acceptance for the remote service remained low, and revenues lagged far behind expectations.

What had gone wrong? The indicated reasons were found in the way how the manufacturer packaged, priced, and sold the service. Remote monitoring was sold as a separate offering, or combined with availability guarantees. As a separate offering, customers were unwilling to pay for a service they considered, above all, beneficial for the manufacturer. As a bundle, the manufacturer incurred hefty penalties when guaranteed availabilities were not achieved. Additionally, the remote monitoring service was to be sold by the same salespeople that were selling profitable maintenance contracts. Because remote monitoring was perceived to be more difficult to sell and yielded lower commissions, sales did not take off.

To overcome such pitfalls, manufacturers need to have a holistic view of service sales. This chapter argues why the transformation of the sales function is fundamental to managing industrial services successfully and describes some of the levers that managers in manufacturing firms can pull to achieve this objective.

2 Moving from Reactive to Proactive Service Selling

After-sales services have become a source of stable, profitable revenue for many manufacturers. In particular, firms holding dominant market shares have been able to secure substantial revenues from commissioning, maintaining, or upgrading the installed base. Consider the case of a Swiss textile machinery manufacturer. For years, they held over 80% market share for some niche products, without having to proactively sell services. Instead, once a machine broke down, customers requested urgent support or spare parts, being ready to pay a premium for the time and materials required to get the machine up and running. In short, services sold themselves.

The outlook is, however, less bright in other markets. Our work in the automotive industry suggests that OEMs have tightened their grip on service purchasing policies. Pressure trickles down to upstream suppliers that need to present a compelling business case to secure orders for machinery and services. Asian markets are also challenging. European OEMs have struggled to increase service revenues for years. Our research in the region identified three major barriers to that objective:

1. Cultural values considering services as an integral part of business relationships
2. Local competitors providing spare parts and maintenance labor at a fraction of the OEM's price

3. Local customers spending less on maintenance activities, by reverse engineering spare parts or disregarding recommended machine maintenance cycles.

Moreover, digital technologies change how manufacturers create and capture value from industrial services. Nowadays, many industrial goods leave the plant with built-in sensors and data transmission components. Manufacturing companies harness this IoT technology to offer smart services that enable data-driven decision-making. Because smart services are delivered with digital means that could make field service redundant, manufacturers need to consider new paths for selling and monetizing these offerings. Opportunities and challenges lying ahead of manufacturers aiming to develop service sales capabilities are introduced in the following.

3 Pinpointing the Gap in Current Service Sales Approaches

The benefits of building service sales capabilities exceed short-term income improvements. Arguably, having frontline employees trained in negotiation techniques may help to sell that additional spare part or close the deal for a big-ticket maintenance contract. However, this game is won in the long run. Lifetime revenue from servicing industrial equipment can exceed the initial transaction price multiple times (Benjamin, Brink, Kervazo, Lavandier, & Rozenkopf, 2019). To maximize customer lifetime value (Kumar & Reinartz, 2016), sales approaches need to foster long-term relationships based on customer satisfaction and, therefore, retention. Taking a longer-term view is even more important for new, smart services because they potentially need iterative adjustments and unfold their value potential over a longer period of time (Sjödin, Parida, Jovanovic, & Visnjic, 2020).

Four caveats to consider when selling industrial services are summarized in Table 1. We briefly touch upon each of them subsequently.

The fundamental challenge underlying service sales approaches is that, often, there is none. The example of the textile machinery manufacturer is revealing. No proactive service sales process was in place because the entire service organization was geared toward reacting to customer inquiries. On the flip side, given the firm's strong footprint in Asia, customers were often unwilling to pay at all for services. The manufacturer all too often followed these requests, albeit reluctantly.

The lack of a dedicated service sales approach entails the risk of miscommunicating the value of services. If equipment salespeople are entrusted with selling new, advanced services, they may fail to fully grasp the benefits created on the customer's side (Kindström, Kowalkowski, & Alejandro, 2015). If the value provided by the service is inadequately communicated, customers are unlikely to sign a contract. Our research suggests this issue is exacerbated with digital offerings. In many of our interviews, potential users of remote monitoring services expressed difficulties in recognizing the value of these offerings.

Such smart services call for new revenue models, which are difficult to implement. Prices for industrial services are usually set with cost-plus approaches (Morris

Table 1 Four caveats to consider when selling industrial services

	Manufacturing companies as service providers	Business customers as service users
Selling approach	• Not used to sell services proactively • Give away service free of charge	• Expect free services
Service value	• Limited understanding of a service's benefits • Difficulties in communicating service functions and benefits to customers	• Limited understanding of a service's benefits • Often no proactive demand for new services
Revenue model	• Lack of experience with "unconventional" service pricing beyond cost-plus/time and materials • Billing processes not adapted to new revenue models	• Lack of experience and acceptance of "unconventional" service pricing • Difficulty in budgeting for variable pricing (e.g., performance-based contracts)
Performance measurement	• Main sales KPI is aggregated sales revenue • Low incentive to sell services	• Main purchasing KPI is cost savings • Low incentive to buy services that unfold value over time

Source: Own research

& Fuller, 1989). With smart services, less time is spent in customer-facing interaction, such that value-based pricing becomes more relevant (Töytäri et al., 2018). Looking under the hood of new revenue models, however, reveals several challenges. Only the minority of industrial firms we worked with had the capabilities and resources required for computation and implementation. For instance, to implement pay-per-use or subscription pricing mechanisms, firms need to adapt billing and accounting processes to smaller, recurring payments. This poses a major practical challenge for many ERP systems. Furthermore, not all customers embrace new revenue models. When maintenance budgets are set annually, little room is left for variable payments, as stipulated by pay-per-use mechanisms.

Finally, performance measurement systems on both seller's and buyer's side may lead to tensions. On the sales side, aggregated revenue incentives can pose problems. If initial equipment sales revenues are much higher than service revenues, but sales incentives are aggregated over both, salespeople are unlikely to allocate much resources and effort in selling the latter (Reinartz & Ulaga, 2008). Now, considering that some smart services sell for a few hundred euros per year, this conflict is likely to persist in the years to come. On the buyer's side, shortsighted incentive systems impede mutually beneficial outcomes. In the automotive industry and beyond, professional buyers are incentivized to reduce purchasing prices at the moment of transaction. Our experience suggests this also applies to services. In consequence, some services create enduring customer value over time and are priced accordingly but struggle for acceptance for this very reason.

Failure of service sales initiatives mainly occurs at four organizational levels: strategy, processes, roles, and competencies. A common shortcoming is the lack of *strategic guidelines* (see Chap. "Service Strategy") before venturing into service sales. New services are prone to fail in the market when insufficient attention is

directed toward setting a strategic objective prior to the launch. Given that most manufacturers already offer a broad range of aftermarket services, any new offering needs to be scrutinized for potential substitution effects. Fundamental decisions concerning the markets covered, the timing of commercial initiatives, and the pricing strategy followed should be part of any go-to-market plan.

Processes are another source of failure. The example of the textile machinery manufacturer showcased what may happen when there is *no* service sales process. But even if there is one, sales success is not a given. A machinery manufacturer introduced a new smart service to multiple pilot customers. The number of leads in the sales funnel grew quicker than the sales organization could keep up with customer requests. This would have been crucial, as the service required a high degree of customization and explanation. Some customers dropped out of the sales funnel for that reason, while others staying inside felt insufficiently advised.

Similarly, *roles* for service sales may be ill-defined or inadequately filled. The second mistake the aforementioned machinery manufacturer did was to let the product owner of the new service also sell it operatively. Boundaries between roles were blurred, resulting in delays in product development and lost sales. Moreover, sales roles can be inadequately filled. Another machinery manufacturer elected a seasoned service sales consultant to also sell recently introduced smart services. Yet, because these new smart services required different ways of approaching stakeholders in the customer organization, sales did not take off.

This example also reveals a competency gap. Service sales require a set of knowledge, skills, and abilities that frontline employees need to develop. Because service representatives frequently interact with customers, they are well positioned to recognize customer needs and sales opportunities (de Ruyter, Keeling, & Yu, 2020). However, not every good service technician is an equally good salesperson, and examples of failed attempts to blending both roles are well documented in the literature (e.g., Hughes & Ogilvie, 2020). Skills can be enhanced if a firm has a set of selling approaches readily available. The capability of identifying, assessing, quantifying, and communicating customer value is crucial for selling services and becomes even more important for smart services (Classen & Friedli, 2019; Töytäri & Rajala, 2015). Still, many manufacturers lack this ability. This shortcoming goes hand in hand with insufficient knowledge about customer needs and the value effectively delivered to customers.

Postmortem analysis of failure in service sales leaves decision-makers in manufacturing companies with several questions: How to overcome the reluctance of customers to pay for industrial services? How to escape the dilemma between customer-retaining and revenue-generating service activities? What capabilities are crucial to selling smart services? Some of these questions will be answered in the following to chart the way forward in industrial service sales.

4 Way Forward: The St.Gallen Industrial Service Sales Framework

The St.Gallen Industrial Service Sales Framework (see Table 2) advances two groups of levers that can be pulled to sell industrial services successfully. We call "Market Levers" the externally oriented options for shaping a service offering. The realization of the opportunities created by the Market Levers depends on the corresponding Organizational Levers. These internally oriented enablers are required to put the Market Levers into action.

4.1 Market Levers

4.1.1 Market Strategy

In line with the overall service strategy, the market strategy sets the primary goal for introducing a new service. Three generic goals for a service business were established in Chap. "Service Strategy": improving the strategic position, increasing market penetration, and increasing income. The same set of options is available when establishing a market strategy for a new service. The hereby defined goal serves two functions. First, it helps to achieve fit with the overarching service strategy. Second, it paves the way for all subsequent offer structure design choices.

Relentless segmentation is essential to channel resources in service sales toward the most promising leads. That is necessary because purchasing policies for industrial services vary between two extremes. On one end of the spectrum, potential service customers may be endowed with substantial in-house resources to maintain industrial goods. On the other end, maintenance is considered a non-core capability that businesses are eager to outsource. Thus, manufacturers need to tap on existing sources of data to identify the customers having the largest propensity to buy services (Benjamin et al., 2019).

This imperative applies to smart services in particular. We worked with a global industrial conglomerate on the introduction of a predictive maintenance service and with a machinery manufacturer on a remote monitoring service. Both services were found to be requested mainly for critical operations. Customers not operating under just-in-time schedules, with low capacity utilization, or with equipment

Table 2 St.Gallen Industrial Service Sales Framework

Dimension	Market levers	Organizational levers
1	Market strategy (goals, segmentation, pricing strategy)	Competencies (knowledge, skills, abilities)
2	Revenue model (offer structure, pricing mechanism, price level)	Organizational configuration (roles, processes, structure)
3	Channel management (direct channels, indirect channels, account management)	Sales governance (performance management, incentives, controlling)

Source: Own research

redundancies, were excluded. According to the smart service business developer in charge, customers' pain was simply not great enough to invest in predictive services.

The pricing strategy builds on the decision between skimming and penetration. Certainly, there are more facets to pricing new products (Ingenbleek, Frambach, & Verhallen, 2013). However, because this decision entails a fundamental choice between relatively higher or lower price levels, it is arguably the most important one.

Anecdotal evidence suggests that manufacturers pursue distinct pricing strategies for their physical and smart service business. For physical services, many manufacturers leverage a skimming strategy. Premium prices for troubleshooting interventions and spare parts provision can be commanded because customers typically have no other choice than to accept these offers in their state of distress.

The situation for smart services is more nuanced. At the current stage, many manufacturers face a goal conflict. On the one hand, they try to collect massive amounts of equipment data to make their services "smarter." Each incremental service user generates some data, which is expected to improve the service marginally. The case of Heidelberg in the second part of this book illustrates how manufacturers exploit such network effects.

On the other hand, manufacturers are investing significant human, technological, and financial resources in building digital capabilities to drive smart service development. As with any profit-oriented organization, manufacturers prefer recouping these expenses sooner rather than later. These conflicting goals require a fundamental decision between a penetration or skimming pricing strategy.

In our experience, larger industrial firms tend to prefer smart service pricing strategies that unfold in two stages. In the market introduction phase, a penetration strategy is pursued—if the firm's liquidity allows for it. This is done to turbocharge growth of the data-generating user base, potentially at the expense of immediate returns. In a more mature phase, manufacturers are likely to leverage lock-in effects and introduce higher-value functions to command higher prices and appropriate economic rents from services.

4.1.2 Revenue Model

The first decision in structuring a new service offer is to choose from three generic bundling strategies (cf. Adams & Yellen, 1976):

- *Pure* bundling: Services are only sold in packaged form.
- *Mixed* bundling: Services are sold in packages and separately.
- *No* bundling: No service packages are offered.

Provider- and customer-led motivations guide this choice. Providers have many reasons to bundle, most of them induced by profitability objectives (Wübker, 1998). In particular, a mixed bundling strategy may prove beneficial for both sides because the provider sells more products and the buyer enjoys a lower aggregate price (Tellis, 1986).

Customers may have preferences for or against bundling. Bundling can help to reduce the perceived complexity of the purchasing process. This is advantageous

when the different service components are difficult to explain. But bundling can also be required for functional reasons. We have encountered smart service offerings with three main functions: data collection, visualization, and analysis. The first function is necessary to provide the two others, so bundling logically ensues. However, other situations prohibit bundling. Tenders found in large-scale infrastructure projects include precise requirements for a service's functions. For such situations, off-the-shelf bundles are inadequate to cater for customer needs. Service bundles have to be precisely tailored to be considered and ultimately win the tender.

The bundling strategy for smart services needs to consider complementarity and substitution effects with the existing service portfolio (Classen & Friedli, 2021). For instance, remote monitoring is effective only if changes in an equipment's condition trigger predefined physical action. Wherever possible, providers are well advised to bundle remote monitoring with complementary on-site physical intervention. In other cases, substitution effects are at work. An augmented-reality-guided remote assistance service can replace on-site interventions of service frontline workers. Arguably, these two services should not be bundled.

Pricing mechanisms are defined in five dimensions (Classen & Friedli, 2021). First and foremost, whether or not to *charge* a positive price for a service needs to be established. Importantly, a free service can still support a skimming strategy. We have observed manufacturers offering smart services free of charge to drive sales of high-margin spare parts.

Second, the *invoicing mode* defines the billing intervals. Inspired by digital offerings in consumer markets, subscription revenue models (Chen, Fan, & Li, 2016) are defined by monthly or recurring billing and are becoming increasingly popular for smart services.

Third, the *price metric* sets to what unit(s) a price is applied (Nagle & Müller, 2018). Smart services have led to a surge of new price metrics, notably based on usage. These models are also known as pay-per-X and "tie payment to the customer's use intensity of the service" (Classen, Blum, Osterrieder, & Friedli, 2019, p. 63). However, some sanity checks are necessary before introducing pay-per-X. A manufacturer of marking lasers considered the introduction of pay-per-mark pricing. However, this idea was quickly abandoned for two reasons. For one thing, it was hard to determine precise guidelines for a "good" mark. A camera surveillance system was installed to check the quality of marks. However, the system produced false negatives, claiming that parts were marked badly when, arguably, they were not. Frequent disputes with the laser marker manufacturer followed. They were expected to grow if pay-per-mark were introduced, thereby raising the stakes on both sides. For another, customers were not interested in paying per mark. Laser markers were of exceptional quality and durability. Therefore, customers were satisfied with purchasing the equipment and writing off the investment over a long period. Additionally, customer value was driven by the number of *overall* good parts produced. Just having the part well-marked was insufficient for a part to be considered good. Hence, pay-per-mark did not align with customer value and was abandoned.

Fourth, the *pricing logic* (Töytäri, Keränen, & Rajala, 2017) defines the main source of information for setting the pricing level. For a new offering, three sources of information are available: customer value, competition, and cost (Ingenbleek, Debruyne, Frambach, & Verhallen, 2003). Our experience across industries suggests that many manufacturers strive to introduce value-based pricing for their smart services, but face difficulties, notably in quantifying and communicating the value of these new offerings.

Fifth, the *price level* establishes the number of monetary units charged to the customer. Our research revealed that manufacturers pursue different policies for setting global service price levels (Classen & Friedli, 2021). In the physical service world dominated by cost-plus pricing, price levels for service missions are usually adapted to local labor rates. Approaches for smart services are more diverse. We found cases where price levels were uniform across the globe. As a consequence, service sales were sluggish, particularly in emerging markets, because smart service fees were too high compared to local wages (Classen & Friedli, 2021).

4.1.3 Channel Management

Selling industrial services is mostly a people's business. The preferred sales channel for physical services is the service and sales frontline. "One face to the customer" is an important yet inconsistently applied principle. The role of an account manager is to nurture customer relationships and channel resources to satisfy emerging customer needs from a single point of contact (Sheth & Sharma, 2008). In reality, though, there are frequently two or more faces to the customer. We have observed cases where equipment salespeople, service technicians, and area sales managers interacted with customers regularly. Consequently, customers contacted all three in case of breakdowns, causing massive internal coordination efforts on the supplier side.

Industrial services are likely to remain high-touch even in the digital age. First, because many assets still require regular physical maintenance, frontline employees will continue to visit and interact with customers on service missions. Second, not all interactions can be executed digitally. Particularly for customers in Asia, face-to-face interactions and socializing are a prerequisite before concluding any sales deal. The social aspect of services is unlikely to lose importance in the foreseeable future.

Still, digital sales channels gain increasingly in importance. Industrial buyers have become used to the effortless shopping experience and convenience of digital platforms in their private life. Inevitably, this level of expectations permeates to the working environment. Manufacturers are gearing up by launching enhanced digital platforms, featuring spare parts orders, online training, and so forth. Yet, B2B is not "amazonized," as the e-platform product manager from a leading global manufacturer of industry equipment put it. B2B e-commerce involves purchasing orders, cost centers, and approval processes. The seamless electronic shopping experience from consumer markets is inevitably lost. Customers, some of whom still use fax machines for ordering parts, need to switch gears in their internal purchasing processes to reap the benefits from e-commerce.

Indirect sales channels add another layer of complexity. Manufacturers often rely on local partners, such as distributors or service agents, to deliver services in even the most remote locations of the world. As argued in Chap. "Customer Relationship Management and the Value Network", introducing smart services in the equation changes the rules of the game. Because sales partners earn through commissions and local service delivery, smart services can become a threat to their core business. Hence, manufacturers need to ensure that local partners capture a fair share of the value created by smart services.

The following example of an engine manufacturer suggests one possibility to align interests. The firm sells engines and after-sales services worldwide through subsidiaries or local partners. A recently introduced remote monitoring service is sold and delivered from the firm's headquarters and global hubs. If the need for intervention is detected, local partners are commissioned to maintain and repair the defective equipment. Thus, local partners benefit in two ways. First, they still earn from repair jobs and spare parts installations. Second, because service missions are now scheduled in advance, capacity planning is facilitated and technicians' idle time is reduced.

Account management has to reconcile the offline and online worlds to secure account profitability. Because analogous and digital channels coexist, controlling the total costs to serve a customer across channels becomes essential. Consider how a building component manufacturer uses cost controlling to trigger action in account management. The firm measures account profitability by subtracting the cost to serve a customer from the revenues generated from that account. Decreasing profitability triggers a twofold set of actions. Either new sales initiatives are launched to increase revenue or channel management is scrutinized for opportunities for reducing the cost to serve.

4.2 Organizational Levers

The internally operated Organizational Levers complement the externally oriented Market Levers. Three groups of Organizational Levers are detailed, subsequently.

4.2.1 Competencies

Service sales capabilities are grounded in individual competencies. The skillset required for selling complex industrial services is well documented in the literature. Key competencies include (Ulaga & Kohli, 2018; Ulaga & Loveland, 2014):

- Understanding the customer's business model
- Piercing through ill-defined customer needs
- Fostering long-term customer relationships
- Reducing uncertainty pertaining to the service's outcome
- Selling value and outcomes instead of product functions

These competencies become even more important for smart services. We have witnessed numerous cases where new smart services were commercialized based on a technology push. However, considerable uncertainty subsisted about *how* this service would respond to customer needs. To overcome this uncertainty, manufacturers with advanced service sales capabilities use joint workshops with customers to carve out their explicit and latent needs. Solutions hereby co-developed typically achieve a fit between customer needs and service functions.

New methods for the front- and backstage complement individual sales skills. In the frontstage, ethnography-inspired methods are gaining importance for smart services designed to integrate further into customer processes. To understand how a new offering improves processes, a myriad of methods is available to observe customers' activities and analyze changes triggered by smart services. This data is combined with calculation methods deployed backstage to quantify customer value.

Finally, learning at the individual level needs to be complemented by systematic knowledge management to avoid capability dissipation. Customer relationship management (CRM) systems to track customer interactions and store market knowledge are becoming state of the art even in smaller companies. However, given that service selling is still a people's business, much of this knowledge is stored in the minds of frontline employees instead of within the CRM system. As many of these people are approaching the age of retirement in Western Europe, the threat of losing valuable information is real. As a consequence, manufacturers need to deploy systematic knowledge management systems to generate, disseminate, and respond to market intelligence (cf. Kohli & Jaworski, 1990).

4.2.2 Organizational Configuration

Introducing new roles is a preferred way of institutionalizing proactive service sales in a manufacturing company. Using dedicated service sales roles, as many manufacturers already do, is not the end of the story. In particular, manufacturers at the forefront of smart service commercialization have introduced the role of service consultants to foster customer orientation in service sales. A building equipment manufacturer provides a blueprint to follow. Given that the company employs a large direct sales force, sales efficiency and effectiveness are critical. These goals were achieved by introducing the new role of the service consultant. Instead of elaborating on technical specifications, service consultants are driven by bottom-line improvements for the customer. Consultants rigorously analyze customer processes to develop tailored, smart service solutions, leading to overall higher customer satisfaction and profitability.

Inevitably, new roles call for adapted sales processes. Innovative approaches to identify and quantify customer value were detailed earlier. Nonetheless, processual reconfiguration does not stop here, as two examples show.

For one, pricing processes are subject to major revisions. Due to the inherent subjectivity and context dependence of customer value, many manufacturers feel uncomfortable to depart from tried-and-tested cost-plus pricing to start considering value-oriented approaches. Our research, however, suggests that transitioning is

imperative and requires some top-management involvement to drive processual changes in the global marketing and sales organizations.

For another, sales processes for smart services need to be agile. Many of the smart services we encountered were launched without a thorough understanding of their value creation potential. Against that backdrop, customers requested trial phases to evaluate a service's value before investing in them. Providers needed to adapt sales routines to include systematic feedback loops with pilot customers and adapting contractual agreements for current and future customers.

There is a vast number of options to organize service sales. As argued in the Chap. "Organizational Structure," a majority of manufacturers have chosen to pool service activities in a separate organization. For instance, an elevator manufacturer has separated New Installation sales from Existing Installation sales. The latter function covers all types of after-sales services. Yet, the interplay between service and sales can be more complex. Globally operating manufacturers tend to organize their global account management around geographical clusters and countries, such as "Asia Pacific" and "Thailand," respectively. The same manufacturer uses bilateral communication channels at different hierarchical levels for strategic partners. On the most senior level, global account managers at the manufacturer's headquarters interact directly with a global function on the customer's side. On a more operational level, country key account managers interact with national customers. They organize service intervals, identify additional sales opportunities, and sign long-term service agreements.

"Digital" adds another layer of complexity, as shown by the following example of a machine tool manufacturer. For the pilot phase of a new service, the firm introduced a "Business Development Smart Services" function to develop world-wide leads for smart services. Customer care was then gradually handed over to local subsidiaries once the service was established. Still, license management remained scattered over legal entities. Subsidiaries sold user licenses for the smart service to national customers. Licenses were managed by the headquarters. In consequence, transfer price agreements were settled between headquarters and subsidiaries to reward subsidiaries for selling smart services while establishing a single point of truth for license management.

4.2.3 Sales Governance

The Sales Governance Lever encompasses mechanisms to ensure effective planning and steering of the service sales organization. From a planning perspective, integrating financial and non-financial leading indicators is essential to ensure holistic, forward-looking performance management. As for financial leading indicators, Software-as-a-Service (SaaS) companies may serve as role models. For instance, SaaS pioneer Salesforce prominently reports "Remaining Performance Obligation" (RPO) in its annual report. RPO is "all future revenue under contract that has not yet been recognized as revenue and includes unearned revenue and unbilled amounts" (Salesforce, 2020, p. 42). RPO serves as a yardstick for the performance of Salesforce's subscription business, as it indicates the magnitude of recurring revenues to be expected in the quarters to come. Manufacturers beginning

to offer smart services with revenue models based on recurring cash inflows are well advised to consider similar performance indicators. Specifically, when a large share of customers is under free trial contracts, static measures of service revenue in a given fiscal year do not accurately reflect the future revenue-generating potential of the existing user base.

As for leading nonfinancial indicators, customer satisfaction measured by the Net Promoter Score (NPS) is a double-edged sword. We observed an increasing number of manufacturers introducing NPS as a proxy for future revenue in their service business. Yet, using NPS can lead to some distortions, as the experience of a building component manufacturer shows. The firm piloted NPS in two core markets—the USA and Japan—with some ambiguous results. The average NPS computed from the US customer survey was around two points (out of ten) above the Japan score. Was the service in the USA that much better than in Japan? According to the global division executive, it was not. To him, American customers tended toward an upward bias in their service evaluation, while Japanese customers were more cautious in their ratings. In the same vein, established service research has long shown that cultural factors influence service quality expectations (Donthu & Yoo, 1998). Thus, introducing NPS needs to be complemented by measures to reduce cultural bias.

Individual salespeople's incentives require alignment to this forward-looking performance measurement. Goal conflicts induced by incentives solely based on aggregate equipment and service sales revenues were sketched earlier. To avoid this distortion, multidimensional incentive systems become more common in sales (Capgemini, 2008). Several manufacturers have already introduced additional sales targets based on contribution margin. However, we expect the adjustments in the overall performance measurement to trickle down to individual targets. Goals relating to the share of recurring revenues in total sales are likely to increasingly permeate into sales force objectives.

Two examples show how forward-looking metrics fuel controlling mechanisms to steer the service sales organization. The *hit rate*, as in the volume of contracts closed per sales interaction, reveals the efficiency of sales processes. A low hit rate calls for better segmentation of customers and sales territory re-design, such that the right companies and the right people within these organizations are targeted. The *share of wallet* in a customer's maintenance expenditure allows assessing the extent to which the service provider is involved in maintenance activities. Measures targeted at customers with a low share of wallet unfold in two distinct ways. On the one hand, there might be customers with a large internal maintenance organization, where approaches to selling traditional maintenance services are unlikely to succeed. These customers, however, offer an opportunity to promote remote monitoring services, enhancing the efficiency of the maintenance staff. On the other hand, there might be customers having outsourced a large share of maintenance activities to third parties. In this scenario, a preventive maintenance service can help to recoup some of the lost service revenues because it triggers preemptive action from the manufacturer's service field force.

5 Managerial Implications

We suggest addressing the Market Levers before pulling the Organizational Levers. Foremost, the design choices made on the Market side have a strong influence on the appropriate configuration on the Organizational side. Just consider the case of a service sold indirectly. Sales capabilities have to be developed outside the focal firm. Organizational configuration and governance mechanisms are relevant only at firm boundaries and at the local partner, not on the individual salesperson level within the firm. In addition, experimenting with the Market Levers first permits a clean-sheet design of new service offerings. More design options come to mind if path-dependent organizational factors are left out in a first iteration. In a second iteration, managers can match the Organizational Levers to Market Levers and readjust on both ends, if needed.

Market Levers should be operated in the sequence presented in this chapter. We strongly advise managers to take the time to define the market strategy of a service *before* discussing its revenue model. In our work, we have frequently encountered companies plunging into crafting advanced pricing mechanisms before even discussing whether full value capture was in line with the service's strategic goals. The same applies to channel management. Knowing whether a service is intended to earn direct revenue, as opposed to, say, leverage lock-in effects, is fundamental for defining the appropriate account management actions.

Organizational Levers should be prioritized according to the maturity of the sales organization. Companies with low maturity typically lack proactive service sales. Such companies are urged to revisit the skillset of their current sales force in the first place. Early readjustments might be required before addressing greater organizational reconfiguration. Companies with intermediate maturity may have the right salespeople and capabilities, but an inadequate organization to leverage them. In such a case, we suggest sketching archetypical service sales roles before integrating them into adjusted service sales processes. To gain speed, roles and processes can be adapted without amending the overarching organizational structure. This may follow at a later stage. Finally, mature companies have the right capabilities and organization in place to sell services. These companies should introduce periodic checks to ensure their performance management system remains in line with organizational adjustments.

6 Summary

This chapter has presented Market and Organizational Levers that can be combined to penetrate markets in the short term and earn income in the long term. Decisions on the market strategy shape all subsequent Market Lever design choices. The revenue model is a multidimensional construct that defines whether, how, when, and how much revenue is earned with a service. Channel management becomes increasingly complex in times of smart services because boundaries between physical, digital, and indirect sales channels vanish.

Market Levers are effective only when a corresponding organization is in place. Even a consistent revenue model is unlikely to succeed if frontline employees are unable to explain it to prospective customers. The most seasoned service seller is incapable of fostering long-term customer relationships and profitability if protocols and incentives are not in place. So, to sell services successfully, we offer manufacturing firms a tripartite set of Organizational Levers, consisting of competencies, organizational configuration, and sales governance. The market-oriented sales organization needs to be complemented by a customer-centric service operations organization that is as agile as efficient and effective, as Chap. "Service Operations," puts forward.

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Service Operations

Jonathan Rösler, Philipp Osterrieder, and Thomas Friedli

All of the real heroes are not storybook combat fighters either. Every single man in this Army plays a vital role. Don't ever let up. Don't ever think that your job is unimportant. Every man has a job to do and he must do it. Every man is a vital link in the great chain.
—General George S. Patton

Key Takeaways

- Service operations management reflects a field that is most often not seen on the top of the agenda at manufacturing companies, but it is of crucial importance.
- Service operations have a significant influence on customer experience and satisfaction, which is why manufacturers should embrace the opportunities professional management brings with it.
- Digital technologies create various additional opportunities to leverage internal efficiencies and to generate substantial value for customers.
- Yet, service operations organizations oftentimes experience conflicts of goals arising from misalignment with either corporate strategy or with other main functions.
- Despite the challenges, manufacturers need to start to guide their organization toward superior and sometimes digital enhanced service operations.

Service operations complement service innovation and service sales treated in Chaps. "Service Sales," and "Service Operations," to a fully integrated offering. It

J. Rösler (✉) · P. Osterrieder · T. Friedli
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: jonathan.roesler@unisg.ch; philipp.osterrieder@gmx.net; thomas.friedli@unisg.ch

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is a long way from the initial idea to the concrete design and finally to the successful provision of a service to the customer. Each stage in the service lifecycle has to provide value to the business, whereby the actual service delivery and its operation is a crucial step. Service operations are vital for the customer and the provider as the very design and execution of these operations are decisive for success or failure. The field of service operations, therefore, becomes a centerpiece of professional industrial service management.

Service operations management covers the activities, decisions, and responsibilities of operations managers in industrial service organizations. It includes the definition and design of suitable management systems to ensure that the services are provided effectively and efficiently. Hence, it comprises both the definition of operational goals based on the company's corporate and service strategy, the planning and design of the service provision in terms of the organization, roles, and processes and also the securing of necessary resources and skills for this task.

The crucial importance and the real scope of this organizational function are often underestimated and can end in disaster. The service operations function is responsible for providing customer support, ensuring the functionality of customer assets, managing the field service force, maintaining customer satisfaction through flawless service delivery, and ensuring flexibility and agility in response to customer requests. Consequently, we define its role as follows:

> The service operations function ensures that service provision and continuous operation over the lifecycle is performed in an efficient, effective, and agile way so that individual customer success is achieved consistently.

In the era of digitalization, the selection, implementation, and management of information systems and associated digital technologies are becoming increasingly important within the service operations organization and can, thus, not be treated in isolation from it. Based on research and various practical insights, this chapter aims to provide managers with orientation, recommendations, and approaches relevant to the field of service operations. We start with a look at the evolution of the service operations organization before elaborating on current opportunities and challenges. The chapter ends with a presentation of advice for professionalizing service operations at manufacturing companies.

1 The Evolution of Service Operations

Historically, traditional product-oriented manufacturing companies did not focus too much on service delivery, and as long as they made good profits in their product business, they did not feel any pressure to change this. With the increasing importance of services, this started to change. An increasing experience, the emergence of new information technologies, and the ongoing global expansion of the service network made further professionalization a necessity. Consequently, companies

had to maintain or regain their agility and flexibility and continuously improve their service operations.

Today, more and more manufacturers are creating the basis for a professional service operations function, focusing on various vital topics. As such, service quality management, continuous improvement toward achieving so-called lean services or service excellence, the merge of back- and front office activities with the field service force, and the management of entire customer processes (often referred to as *as-a-Service* models) are becoming increasingly important.

Often faced with having to make difficult decisions in balancing cost efficiency and customer benefit, the successful management of service operations requires close interaction with service innovation as well as with marketing and sales. The trade-off between costs and customer outcomes strongly characterizes service operations, as the examples in the next sections from industrial practices will show. To overcome this trade-off, a multitude of points have to be considered, from training to the ability to interact with customers and suppliers, as well as to interact within a value network.

Despite the renewed emphasis that came with the advent of smart services, many challenges, such as "How to realize operational efficiencies? How to balance the supply and demand side? Which resources and capabilities are necessary? How to organize and design processes? How to measure performance?", are the same as 10 or 20 years ago and will continue to be valid in the future. However, some answers to these challenges may have changed as in times of increasing customer expectations, growing competition, global supply chains, and significant technological progress, the complexity to deal with it is steadily increasing, and the pressure on service operations executives is rising. As *digital* often neither means effective nor efficient, a new characteristic becomes important and distinguishes successful from most-likely failing service operations managers: take one step back to take two steps forward.

2 Opportunities

Service operations are significantly related to the company's success. Therefore, the ability to design, operate, and continuously improve them ultimately decides success or failure. It has always been a matter for manufacturing companies to act as efficiently and effectively as possible. More recently, and due to the fast-changing environment, the demand for customized offerings, the possibilities of digitization, and the requirements have steadily increased. Services do not any longer just have to be delivered; they have to be a real amplifier for the business of the customers.

Unfortunately, not every newly digitalized service automatically unlocks new potential for the further increase of internal efficiencies in the provision and operation of the services or adds value for the customer. This might be because the design is already flawed, resulting from a missing or inadequate service innovation process (see Chap. "Service Innovation"), or only the service as a product is defined but not the required delivery processes, leading to high process variability.

Although it might be challenging, manufacturers should invest in improving service operations, as it leads to increased competitiveness, higher productivity in the backstage, and the field service, as well as to reduced complexity. Based on general promises related to the application of digital technologies in service operations, we present four distinct opportunities in the following.

2.1 Leveraging Internal Efficiencies

To start, consider the case of a machine tool manufacturer that has always been very successful in developing and introducing new products to the market. Yet, the company's *best-in-class* service concept could only be operated with losses, which is why the competitive position was increasingly at risk. Since the firm's leadership team wanted to act from a position of strength, the responsible service managers were tasked with developing a concept of how to save costs and restructure the service operations organization. The pursued goal was clear but showed a conflict of interest: decrease costs and increase efficiency while not jeopardizing customer satisfaction.

However, a benchmarking study revealed that the manufacturer had the potential to improve internal, often bureaucratic, processes. The company then decided to automate a large number of internal service processes in cooperation with an established implementation partner step by step. The automation of several processes (e.g., from requesting a technician to route planning, incident, and status reports) complemented by connected machine tool storages automatically signaling operations teams and warehouses when reordering became necessary led to increased flexibility and significant cost savings.

In addition, streamlining the processes uncovered that many roles and tasks within the organization were assigned twice and certain escalation procedures were inadequate. It often took several days before critical decisions were made or important customer inquiries were processed. The manufacturer, hence, decided to reorganize the structure introducing considerably faster reporting channels. Adhering to the principle of lean service operations, the organization now annually evaluates possible improvements and strives to systematically collect actionable feedback from employees at all levels.

The case of the machine tool manufacturer demonstrates the first opportunity most companies can take—leveraging internal efficiencies. We found similar situations at several other manufacturers as most professional service operations management is still in its infancy. Former product orientation oftentimes led to unplanned approaches in the service business, whereby purposeful processes were rarely established. While this also accounts for service innovation and service sales processes, the service operations organization should be examined with regard to improving internal processes based on lean service principles.

2.2 Achieving Win-Win

The second opportunity to improve service operations is the possibility to achieve win-win situations. Manufacturers can apply new digital technologies on carefully selected use cases to enhance customer satisfaction, improve customer experience, or even decrease costs for customers while also achieving their own targets.

Take the example of remote monitoring and remote assistance, enabling service technicians to work for a large part out of the local service hub. The time and costs saved by eliminating the requirement to travel directly benefit the provider and the customer. Companies having customers at distant locations profit from this kind of service provision (assuming the customer is willing to accept this). No matter whether the manufacturer uses an augmented reality solution to guide maintenance and repair processes remotely, or connects directly to the machine to perform troubleshooting, applying such technologies regularly creates win-win situations but at the same time requires the adaptation of the service operations organization.

Notably, the implementation of a remote assistance service necessitates significant resources and a sound business model to be profitable for the manufacturer. The service staff has to be trained for the new service approach; the organization requires a sophistication of its information technology systems and a new scheduling system for those service events, which cannot be solved remotely. However, the time of value-adding activities increases, in turn, leading to lesser demand for service staff or an increased number of addressable service incidents.

2.3 Enhancing Core Business Focus

The third opportunity on which we want to elaborate concerns the enhancement of core business functions. Considering a manufacturing company offering physical services, most types of service events require planning and/or scheduling. This can be the timely dispatch of spare parts and service technicians for emergency repairs in case of an unplanned breakdown, a preventive maintenance visit, or the introductory training for new equipment. Concerning smart services, several offers exist as well that require the planning and scheduling of necessary physical interventions. In any case, planning, scheduling, and routing tasks are typically time-consuming and failure-prone but essential within the service operations organization.

We experienced that many manufacturers face the problem of inefficient planning and scheduling, as the companies refrain from the implementation of costly software support. With the emergence of digital technologies, the upgrade to a simplified software infrastructure and software environment is inevitable. For instance, multiple examples exist where manufacturing companies partnered with a software provider to implement a resource management system to optimize the allocation of field resources. The advantages are evident. A consolidated resource management system improves the quality of service since the software allows the combining of individual-level competencies of the staff with forecasted service incidents and online maps. Service encounters are, thus, much more coordinated, leading to

enhanced customer experience and higher customer satisfaction. Further, based on the integrated data, intelligent routing ensures greater efficiency through a higher share of value-adding work hours. Reduced work stress of the planning and scheduling team, as well as for the service technicians due to the support of mobile applications, adds to the mentioned advantages.

Companies may even be able to analyze historical and new equipment (uptime/usage) data to provide insights about the potential to redefine service intervals, to improve product characteristics, and to further reduce downtime.

Complementary to the opportunity of leveraging internal efficiencies where the focus lies on improving internal processes, the enhancement of core business functions concentrates on optimizing actual tasks. Nevertheless, both sections emphasize opportunities manufacturing companies should seize within their own boundaries to professionalize service operations management.

2.4 Creating New Value

The progressing attractivity of as-a-Service business models for both customers and providers will further require changes within the service operations organization to ensure success. Where manufacturing companies can profit significantly from providing products as a service, a highly cost-efficient and high-performing service operation is the key to success. Having full access and control over the assets at a digital operations center enables the company to develop and implement robust prediction algorithms but imposes high responsibility on the service operations organization. In case something goes wrong and the guaranteed availability cannot be met, hefty penalties might result.

With service operations being the interface to the customer, they can create new significant value for him but also be responsible for failures. To be successful, we underlined throughout the book that it does not suffice to professionalize one part of the chain. All parts are equally important, and the opportunity for creating new value exemplifies the statement. Innovation activity results in the task of finding a feasible revenue and business model. Service operations need to be executed with care, and the balancing of costs and benefits. All parts need to be capable of doing their job the best possible way to ensure success.

To reach the state of success, most often, companies have to overcome barriers that accompany the development. Considering the case of as-a-Service business models, one of the biggest challenges for manufacturers is to ensure coexistence with established and maybe competing approaches. Even though as-a-Service models promise high value-add for customers, most likely a manufacturer will not be able to transition the entire customer base to the new business model. The service portfolio is still going to comprise single physical and smart services, besides bundled packages. Consequently, the different opportunities most often come along with substantial challenges, of which we address four different kinds in the following.

3 Challenges

Despite the great opportunities for further optimization in service operations, industrial service managers are well-advised to keep their healthy realism and skepticism. As previously emphasized, the *what* counts less than the *for what* and *how*. The advent of digital technologies is not a panacea for the service operations organization, but it does offer many new opportunities. While formerly most concerns were related to copycat parts and how to deal with competition from low-cost service providers, today, the topics of data security and a lack of resources are more frequently coming into play. Thus, sometimes it is better to introduce a new solution not yet developed to perfection and to improve it quickly with the customer (value co-creation), as spending vast amounts of resources on creating a perfect concept, which could then be dropped afterward.

The idea of simply copying *best practices* for an organization may not work as environment, internal culture, and customer characteristics often vary greatly. Additionally, the question of whether to *customize the standardized* or *standardize the customized* remains a relevant topic for which no one solution can be found. For this reason, we introduce practical, real-world examples intended to illustrate and underline the diverse challenges that service operations managers face today by highlighting the respective context.

3.1 Conflicts of Goals in the Provision of Services

Consider the example of an export-oriented machine tool manufacturer active in the high-tech sector for a long time. Like many other industrial equipment manufacturers, the company started to offer its customers supplementary repair and maintenance services, provided by dedicated field service technicians, at some point in time. While these services were initially introduced as an add-on to justify and keep product prices (i.e., margins) high, the direction of the company shifted toward the desire to make money with the services as well. The resulting pressure to increase service margins led to the unfortunate development of prioritizing customers with a higher willingness to pay more and a deterioration of the service quality at the other customers.

Like many companies, the machine tool manufacturer had failed to align corporate strategy, with service and service operations strategy. As we introduced in Chap. “Service Strategy,” three general service strategies exist, each having distinct prerequisites and consequences for every part of the service organization. A service operations organization erected to deliver high-class physical services and run as a cost center since the main profit is capitalized in the product organization cannot be easily transitioned to a profit center generating the expected revenue.

Goal conflicts exist for many service operations organizations, as they often have to balance costs with reaching superior customer experience and satisfaction. But essentially, the objectives of the service operations organization need to be aligned with the overall service and corporate strategies.

Being aware of possible conflicts can prevent undesirable behavior of the service technicians triggered by the wrong incentives. Instead, aligned strategies can reinforce each other and build a competitive edge.

3.2 Misalignment Between Service Sales and Operations

A common challenge reflects the misalignment between service sales and service operations. Based on the corresponding (and right!) incentive to push new service sales, it regularly happens that operations lack the skills and capacity to support the new services, especially in the transition phase between physical and smart services. The problem is evident. Configuring appropriate service operations structures for new smart services before they get sold, a company risks wasting resources on process alignment, infrastructure, people, and training, in case the service does not take off. But waiting for the sales force to create leads could result in high adoption rates (which again is very positive in principle), putting the service operations organization under extreme pressure to adjust structures and setting up the necessary foundation. While this dilemma may be called a chicken-egg problem, manufacturing companies might be required to invest in the renovation of the software environment before smart services can be introduced to the market. The time needed to simplify processes, to lay the foundation for a central data lake with the respective data quality, and to train people so they can benefit from the new technology is just too long if you start too late.

We, thus, recommend establishing the required basis for delivering and maintaining smart services, but to refrain from going into too much detail concerning specific service offers before their value and attractivity to customers has not been proven. Still, a manufacturer has to anticipate potential ad hoc solutions in case a new service offer takes off quickly. The case of an automotive supplier discussed in Chap. “Service Sales,” showcases how to fail if a company does not possess a fallback plan. In the process of getting beta customers through the sales funnel, the manufacturer was too busy to realize that he was not able to support the continuous service delivery for more than a handful of customers. Moreover, the only people competent enough to support the smart service were highly involved in finalizing service development and in the service sales process. It ended with dissatisfied customers as waiting times became longer and longer, resulting in dropouts that could not be followed up to learn from.

The example shows that manufacturing companies are required to find early leads with customers for improving the service, but they also need to carefully balance sales and marketing activities with the progress of ramping up the service operations organization. In practice, however, we see many companies having glossy marketing material on new smart services, of which a fraction has been sold so far, and delivery has not been thought through.

3.3 Lack of Exchange Between Service Innovation and Operations

Besides the misalignment between service sales and service operations, challenges also arise from a potential lack of exchange between service innovation and service operations. Even though most conflicts are less severe and relevant, service innovation has to be aware of specificities and the competencies of the service operations organization. As service operations are traditionally close to customers and know about the individual competencies of the field force, they reflect a vital input for service innovation endeavors. Consequently, service innovation can prevent many conflicts within the company but also with customers, when they involve service operations appropriately.

Imagine a manufacturer developing a new smart service together with customers that seem highly attracted by the possibility of new data analytics. Yet, the service requires occasional manual intervention and monitoring from local service hubs or service partners that have neither the personnel nor the equipment to operate the service. The manufacturer then has to inform customers about significant delays to ramp up the necessary service operations function, resulting in bad customer experience and dissatisfaction.

3.4 Difficulty in Harnessing Digital Technologies

We elaborated before on the necessity to renew antiquated information technology (not only) at the service operations organization to ease data storage and access, as well as to exploit the potential of converging single data points. In the process of making the organization "fit for digital," manufacturers often feel the reluctance of employees to adopt new technologies. While it is common that not the entire customer base will be attracted by smart services, it can have a significant impact on the overall information quality if even a small percentage of employees are not transitioning to digital tools. Today, a variety of mobile applications exist that supports the sales and service frontline when selling, delivering, or maintaining industrial services. Converging the data from every interaction enables the company to create complete customer profiles with the ultimate goal to serve the customer better. The information is also essential for innovation and sales endeavors, but if the service operations organization has only incomplete knowledge about the customer, it can easily lead to an unfavorable customer experience.

While it can already reflect a great challenge to harness digital technologies in customer-facing areas, (i.e., within the field force), it can be equally difficult to profit from the potential of digital technologies within the service operations organization not having direct customer contacts. Advancing toward smart services imposes significant changes for processes and qualification requirements, as the service operations organization will probably be responsible for keeping the monitoring and predicting systems up and running. Establishing a digital operations center is necessary to scale smart services and increase efficiency in continuous provision and

deployment. But besides the challenge to set up such a central function, regional specificities might require the company to operate local offices, increasing the complexity of managing the digital operations center. Thus, getting to the state of profiting from the potential of digital technologies brings manifold challenges that have to be overcome, grounding on the respective top management and employee commitment, resources, and a long-term vision.

4 Managerial Implications

Company brand, market reputation, and customer trust not only depend on great, innovative service ideas but also on the ability to deliver the value proposition in a continuous, consistent, reliable, and professional manner at a time the customer wants. Underestimated for a long time, the service operations function and its continuous improvement should have high management attention in the service organization, as the lever for company success is substantial.

As shown in the previous two sections, transforming the management of service operations, particularly of field operations, offers significant opportunities for cost reduction and service improvement. Given the many challenges, however, service operations executives are often unable to cope with them. In the following section, we, therefore, want to show five fields of action that decision-makers in service operations should address in any case. We will demonstrate that in addition to the technical possibilities, it is important to involve people and establish a culture in which continuous improvement is lived.

4.1 Defining a Service Operations Strategy

Operations management in the age of digital transformation requires a clear strategic orientation and direction. In line with the St.Gallen Management Model (Rüegg-Stürm & Grand, 2019) and Chap. “Service Strategy,” the operations strategy does not stand alone but is part of a holistic and integrated corporate strategy. This is of crucial importance as a great number of conflicting goals, interests, involved parties, and roles arise from a lack of alignment between the service operations and other functions.

Strategic decisions at the service operations management level are commonly derived from and aligned with corporate strategy, which is why the question of whether a separate service operations strategy is needed at all is discussed in managerial practice. Everyday business practice, however, shows that an individual operations strategy is most often implemented, as consistent decision-making requires a clear order of priorities and a strategic focus.

Today, this applies even more as modern service operations management means, above all, managing complexity. Only with a specific service operations strategy, conflicting goals can be resolved, and effectiveness, efficiency, and agility of the

service operations functions can be ensured. We consequently define service operations strategy as follows:

> The service operations strategy directs how a service organization allocates its resources and sets its priorities for service provision and service operations.

Although we strongly advise manufacturing companies to agree on a service operations strategy, the specific process for formulating the strategy and its content should and must remain as individual as the company is within its particular business context.

As a guideline, however, we suggest addressing the following points:

- Represent the interests and needs of the service operations function early and actively vis-à-vis the top management. The whole organization needs to get to know the specific problems and requirements so that they can be considered in the corporate and service strategy besides getting aligned with the service innovation, marketing, and sales functions.
- Clarify the companies' key priorities, key resources, key activities, and key partnerships within the service operations organization.
- Decide the strategic positioning based on the companies' corresponding skills. Do not lose sight of the core business. Digital should not be a purpose in itself but has to serve customers and help to improve the business.
- Focusing on low cost and premium at the same time is not possible. Do only what the company can and provide the necessary attention, skills, and resources.
- Think long term and align the objectives accordingly. The aim is to ensure continuity in decision-making, especially in rapidly changing times and/or environments.
- Define specific, measurable, realistic, timely, and appropriate goals.

4.2 Getting Started

Considering the plethora of new opportunities the advent of digital technologies offers, combined with the various challenges of the day-to-day business, many service operations managers face a dilemma. They can either start the long journey and digitalize field services and service operations processes, invest, and maybe opt for the wrong software, the wrong trend, or technology or the company chooses to wait for dominant patterns to arise but runs the risk of falling behind the competition.

Examples exist for both scenarios that worked out well but also others that have resulted in substantial failure. However, even in cases where companies decided to pursue digital activities early on, experience shows that too many companies cling to old infrastructure, lack capabilities, and thus do not succeed with digital service operations. Companies do frequently underestimate the expenditure of resources and the necessary infrastructure and capabilities, being key to convert lighthouse projects into general operational practice. Furthermore, companies do mistakenly assume that

the required skills can be fully acquired externally to facilitate digital technology implementation and operation.

To support practitioners in starting with professionalizing the service operations management, we propose the following steps and advice:

- Develop a vision and take the first step, even without fully knowing the second step. Look outward to identify digital trends and options that are most likely to impact the companies' service operations.
- Assess the companies' situation and needs carefully. Start by eliminating weaknesses, and combine digitalization activities with other initiatives. The simple *for what* and *how* should be stressed emphatically.
- Consult external experts who have no particular preference for one technology over another. Never implement alone, but with experts. Invest in real competence; it pays off.
- Orientate measures at solutions that have already been implemented by others. Do not reinvent everything new.
- Limit the number of activities running at the same time. Concentrate on single-use cases step by step. Be able to cancel an initiative if it is found to be unsuccessful or if the circumstances have changed.
- Do not underestimate the expenditures required for investing in people and the necessary infrastructure.
- Transform your legacy infrastructure into dynamic, scalable, and connected infrastructures. This can and will take time.
- Involve the field service team early in the process as they know best what works and what does not. A company requires their commitment to addressing the upcoming challenges.

4.3 Establishing a Culture of Service Excellence

The challenges ahead of manufacturing companies and the service operations organization, in particular in the process of introducing smart services, are manifold. Only manufacturers that manage to embrace this change will be able to remain successful in the long run. The service business experiences a substantial transformation never seen before: from reactive to proactive service management, from static to dynamic and real-time provision, from mainly physical to smart service offers, from individualized to automated, and from close to open, collaborative systems. Hence, establishing a new culture of service excellence becomes a vital task for service operations management.

Unfortunately, the topic is still considered to be of little relevance and understood as a sunshine topic to be dealt with in the future. This assumption is fundamentally wrong as next-generation operating models can and will not work without a deeply internalized culture of excellence among all stakeholders in the service operations organization. Creating an appropriate service culture is essential to continuously work at the highest possible productivity and quality levels. We, therefore, advise

companies to strive for a culture of service excellence and support it with corresponding programs or measures.

The sought mindset is defined by service excellence values, attitudes, and behavior, besides complying with the corporate culture. Yet, the difficulty of any cultural change is that respective characteristics cannot just be changed; instead, the sought-after values need to be communicated and repeatedly demonstrated, especially by supervisors. Service operations leadership should, thus, consider the following three recommendations:

- Establish and reward a *continuous learning culture* through a seamless feedback loop system, systematic knowledge management, as well as an internal and external benchmarking culture. Just because something worked yesterday does not mean it will work tomorrow. The purpose is not to achieve perfection right away but to continuously improve and renew. Even in the digital age, people remain the most important asset. Consider technicians as brand ambassadors that need to be empowered, involved, and trained regularly, and, above all, be able to learn from the customers—they often know better.
- Live and show *customer-centricity* as the company's purpose to provide value to its customers. A company should challenge how employees and managers think about, value, and behave toward customers. An important aspect of customer-centricity is, therefore, that it is a positive culture. The organization should celebrate success, reward, and encourage customer feedback.
- Implement a *leadership culture*. Next-generation service operations leadership means to act exemplary, take responsibility and decisiveness, coordinate, mentor, and, thus, support and not prevent organizational agility. This is the only way to have the necessary team dynamics with which the many small and larger everyday problems can be mastered. Establish a more digital but also more people-oriented culture. If you expect your employees to provide outstanding and bespoke experiences, it means that employees should receive the trust and freedom to act accordingly. To achieve this, management should encourage, support, and empower employees to reach their full potential by delegating power and responsibilities to them.

4.4 Rethinking the Process Landscape

As services are increasingly provided digitally, or at least to some extent, many companies experience that their current way of working and their process landscape is incompatible and no longer suitable for the provision of services. To sustain long-term competitiveness and to create the basis for introducing smart services in the future, we strongly recommend addressing the challenging task of restructuring the organizations' service operations processes and architecture sooner rather than later.

Too often, industrial practice reveals processes that are neither lean nor customer-centric. Companies still have to internalize that future service operations include a central function where all the relevant data points are converged, not working

without robust, underlying process schemes. In particular, processes must focus on customer benefit and, thus, be designed *end-to-end* for speed and agility. Professionalizing service operations management, thus, also means to ideate and implement sound processes that profit from analogous process mapping before going fully digital. It mirrors perfectly the initially introduced idea of stepping back to reach further.

To support the implementation of a purposeful process landscape, we suggest the following:

- Openly discuss and renew established processes—even though it may be difficult.
- Create a process map of all (relevant) operations processes and clearly define the core, support, and management processes. Set tasks, competencies, responsibilities, and interfaces, and determine the lead time of each process.
- Standardize and automate non-critical/non-value-adding processes as much as possible. It allows the employees to concentrate on real value-adding activities.
- Review, analyze, and optimize processes regularly. Consider using value stream analysis and service blueprinting as tools to systematically improve processes and to define reference processes based on well-proven and reality-tested process components.
- Design processes for scalability and flexibility to account for future developments.
- Design processes for transparency and real-time capability, and respect customer integration.
- Do not increase internal efficiency at the expense of customer satisfaction. The balance between standardization and individualization of service delivery should always be viewed from multiples angles.

4.5 Upgrading the Planning, Information, and Control Systems

The evolution of service operations requires the implementation of a new set of capabilities directed and controlled by planning, information, and control systems. The trends toward predictive maintenance services, *as-a-Service* business models, and *digital twins* will offer a completely new way of resource planning and optimization. Where traditional service operations management systems were organized separately, an effective management system for smart services requires integrated service planning, information, and control systems. To operationalize effective, efficient, and agile track and control mechanisms, integration of a variety of input streams is key.

Dimensioning the necessary resources for service operations reflects a major challenge as manufacturers typically experience a high degree of uncertainty in both strategic (long horizon) and operational (job-based) capacity planning, due to fluctuating or uncertain demands for service activities. Moreover, the collection and provision of information are largely limited today. Although manufacturers started to collect certain data, the findings are often not converted into actionable insights, nor

do they include the customer. Root causes are not faulty information systems but the prioritization of traditional indicators not necessarily suitable for smart services. The same accounts for controlling mechanisms, which are still widely in their infancy concerning the special focus on smart service operations. Companies are required to carefully evaluate existing KPIs whether they deliver meaningful insights in light of smart services or to define new indicators.

We conclude with general design rules a manufacturing company should be aware of when addressing the necessary changes in the service operations organization:

- Think and act customer-focused when designing the appropriate systems. Planning service operations should foster superior customer experience and customer success.
- Be aware that reactive, manual, detailed, and long-term planning and scheduling is likely to be substituted by more flexible, automated, real-time approaches shaped by predictive analytics.
- Start to collect and analyze data along the service operations value chain. This allows the company to provide meaningful, timely, and relevant insights into the process and business performance.
- Do not expect the demand for personnel or financial resources for service operations to decrease. Even though digital technologies have the potential to ease service operations and increase their efficiency, the overall service volume is likely to grow.
- Define new KPIs for the service operations organization focusing on customer value and satisfaction and KPIs that are well aligned with service innovation and service sales.
- Implement manufacturing-alike quality measurements along the service operations value chain and track customer success through a new customer success role. Ensure that the results are translated into action with clearly defined responsibilities.

5 Summary

The tasks and challenges of service operations management have always been evolving. In the era of digital transformation, however, manufacturing companies are facing substantial changes that need to be mastered. Throughout this chapter, we focused on a variety of opportunities and challenges related to the service operations organization based on the current state of research and practice. These insights culminated into a thorough set of managerial implications, which are, to some extent, still to be proven in the future as the field of industrial service management has not yet progressed extensively into digital service operations. Nonetheless, we would like to highlight the following three aspects.

First, the advent of digital technologies for service operations creates manifold opportunities, especially inside a manufacturing company. Essentially, a preventive

or predictive maintenance service does not differ greatly from the perspective of a customer. At some point in time, service technicians will arrive with the necessary spare parts and keep the machine up and running. However, the manufacturer can increase its maintenance efficiency significantly by optimizing scheduling, routing, and staffing issues in the connected and data-driven variant. Besides the presented case, there exist various other possibilities to leverage internal efficiencies.

Second, we showed that opportunities seldom come without risks and/or challenges. The core of many old and new challenges of the service operations organization stems from opposing objectives. Misalignment between sales incentives and operational capabilities as introduced above concerns the opposing objectives of generating sales on the one hand and saving costs on the other. Even within the service organization, unifying superior customer experience and low-cost goals impose significant challenges. It is, thus, of tremendous importance for manufacturing companies to align strategies, in turn, relieving the stress among objectives or, at least, providing prioritization.

Third, the essence of the managerial implications shows that endeavors to professionalize service operations management need to be well balanced. For instance, manufacturers should start to carefully embrace digital service operations but prevent either putting too much effort into service products that look well on paper but do not have a market or missing a real opportunity and therefore losing ground against the competition. Responsible managers need to be brave to break with established processes but refrain from seeing digital technologies as a panacea. Or, companies have to adopt a culture of service excellence with the right controlling mechanisms in place without getting too rigid and bureaucratic. Consequently, sustainably successful companies need to develop a sense for the right pace of going digital based on the right approach and the manufacturers' context.

The service operations function is the last part of the internal value chain, also including service innovation and sales. Each of the corresponding chapters provides specific insights about how to professionalize each part individually. However, manufacturing companies ultimately need to focus on reaching mutual reinforcement among all three segments that are enabled by further activities examined in the following chapter.

Reference

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Customer Relationship Management and the Value Network

Philipp Osterrieder

. . . do not spare any reasonable expense to come at early and true information; always recollecting, and bearing in mind, that vague and uncertain accounts of things are . . . more disturbing and dangerous than receiving none at all.
George Washington

Key Takeaways

- Customer data is of the highest relevance for manufacturers, which is why professionalizing the CRM system to efficiently collect, store, and process customer information is inevitable.
- The company-customer relationship evolves from reactive, transaction-based value-in-exchange to proactive, continuous collaboration, and value-in-use.
- The way value is created for the customer increasingly resembles a network, where in each member contributes a share.
- Manufacturers that apply a non-direct sales approach are required to leverage the capabilities of distributors to enable the transition toward smart services.
- Manufacturing companies need to foster partner embeddedness as intermediaries play a vital role to win against new competitors.

Without customers, a company cannot sell products. Without customer knowledge, a company cannot understand their needs. Without this understanding, a company cannot develop the right product. Without the right products, a company cannot be sustainably successful.

P. Osterrieder (✉)
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: philipp.osterrieder@gmx.net

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Customers are, in very broad terms, a source of information and financial means—both necessary and tremendously valuable for the longevity of a company's existence.

In principle, companies in business-to-consumer markets may survive by applying a shotgun approach (i.e., not caring for the individual needs of its customers but serving the market with products in the hope that "someone will buy it"). In B2B markets, however, there are fewer customers, and their bargaining power much higher. Manufacturing companies need to anticipate the problems and cater for customer needs to be successful. CRM is key. But the integration of the customer into product development changed over time, and even nowadays, the degree to which companies emphasize customer inputs varies a lot.

Consider the following example to underline the necessity to professionalize CRM parallel to the servitization journey of a manufacturing company. An automotive supplier once started to develop industrial services at various isles throughout the company, as the process had not yet been structured and responsibilities were unclear. As an effect, the IT department started to construct a new smart service and involved the corresponding service unit only very late in the process. The task of the service unit was now to shape the business model in cooperation with customers to find a possible way of selling the new service. The problem was that customer insight was largely absent at the beginning of service development. Thus, the company struggled even to convince customers to test the service free of charge. While the manufacturer was confronted with a considerable problem of service adoption, one of the main difficulties was to manage all the customer information the employees gathered in the process of going back and forth to the customer. The service required a consultative selling approach, wherefore different employees (sales, tech sales, experts, technicians, IT staff) repeatedly visited the few selected beta customers. The service product manager finally realized that they had no strategy in place on how to cope with all the insights, responses, and feedback they received from the customers. When a customer dropped out of the sales funnel, nobody questioned why. The manufacturer understood at that point that it requires a sophisticated CRM system to 1) converge and condense the information, 2) analyze it, and 3) learn from it to improve future customer experiences.

In the process of value creation, firms do not only experience the rising importance of customers but also an increased complexity due to the inter-relation with multiple partners. In the scope of this chapter, we would like to elaborate on CRM and the value network as enabling activities for service innovation, sales, and operations. CRM, especially, requires more and more attention, wherefore we start with discussing the evolution of company-customer interactions in the following. We then present the development of the value chain to a value network, in which a manufacturing company needs to position itself strategically. The chapter ends with a set of recommendations and a brief summary.

1 The Evolution of Company-Customer Interaction

For manufacturing companies, taking care of customers and nurturing customer relationships is a vital activity that gained significance in the last years. CRM is not only one piece of a puzzle to sustainable growth, but instead it also provides substantial input to industrial service management.

Essentially, a CRM system can emphasize operational, analytical, or collaborative value. The analytical type of CRM, for instance, may be able to examine customer history, preferences, and profitability information from the available data. It further offers the possibility to analyze, predict, and derive customer value and behavior besides forecast demand. Implementing an analytical CRM system consequently supports in serving the customer with relevant information and a value proposition tailored to the corresponding needs. The operational type focuses on easing the company-customer interaction across multiple channels, while a collaborative CRM caters for efficient integration of the entire supply chain (Adhikari & Adhikari, 2009).

So, how should manufacturers use CRM? During a benchmarking study at the Institute of Technology Management of the University of St.Gallen (ITEM-HSG) in 2018, we asked manufacturing companies how they apply CRM. We provided the following four possibilities: (1) collection of all customer data in one database, (2) integration of the information systems across all units, (3) capturing data from every customer touchpoint, and (4) use of data between different information systems.

Between 41 and 53% of the respondents ($n = 80$) use CRM in one of these presented ways to at least a fairly great extent. It shows that the adoption of CRM (concerning the four displayed options) could still be improved among manufacturing companies.

However, these options focus on the technical characteristics of a CRM system. CRM has been approached from different perspectives and undoubtedly contains a large IT component with the goal to manage customer data, but it also pertains to marketing aspects with a high focus on relationship marketing. CRM is a broad concept, and to clarify this, we draw on the definition by Payne and Frow (2005, p. 168):

> CRM is a strategic approach that is concerned with creating improved shareholder value through the development of appropriate relationships with key customers and customer segments. CRM unites the potential of relationship marketing strategies and IT to create profitable, long-term relationships with customers and other key stakeholders. CRM provides enhanced opportunities to use data and information to both understand customers and cocreate value with them. This requires a cross-functional integration of processes, people, operations, and marketing capabilities that is enabled through information, technology, and applications.

Connected to their definition is the creation of a framework covering five different processes, which are part of a holistic CRM strategy. Payne and Frow (2005) include strategy development, value creation, multichannel integration, performance

assessment, and information management process in their framework. It underlines what we expressed before: A purposeful CRM strategy affects industrial service management at various interfaces.

Yet, in the scope of this chapter, we will not treat all related aspects of CRM. The following paragraphs highlight the change in customer interaction and relationship for manufacturing companies, due to the introduction of industrial services.

1.1 First Efforts

In the early phases of the servitization journey, manufacturing companies often already established long-term relationships with customers. It is a known business logic that satisfied customers are more likely to stay with a particular supplier. When a manufacturing company is thus able to deliver superior products with high perceived value by the customers, it typically turns into high customer satisfaction. As an effect, satisfied customers are less price-sensitive, when manufacturers start to provide first physical services or introduce new product generations.

Consequently, firms employ account management teams and salespeople that look after their customers. Relationship marketing is thus found in bits and pieces throughout the company, even at the beginning of the servitization journey, but is rarely managed with explicit concepts, models, or strategies.

In regard to (digital) customer engagement strategies, traditional product manufacturers lag behind other branches. During the same benchmarking study mentioned above, we inquired which means these companies use to engage with customers (i.e., to develop customer relationships). The top 3 approaches were periodic notifications about new products/services (53%), exclusive events (60%), and key account management teams (78%).

The major part of customer touchpoints still reflects traditional interaction models, even though the focus shifts from individual product sales or service transactions to contractual agreements and longer relationships. However, especially at the beginning of the servitization journey, most manufacturing companies execute single transactions, for products and physical services equally, which may not require a higher degree of customer interaction. At this stage, companies are mostly reactive to customer requests or complaints, customer touchpoints are infrequent and mainly focused on sales cases or service incidents, and the main value comes from product or service features (Hood, Brady, & Dhanasri, 2016). Timewise, the main work of key account management teams or similar salespeople can be characterized by two seasons: time of sales and time between sales. During the time of sales, the interaction may be high to close the deal, while in the time between sales, touchpoints are usually rare and mostly reactive to customer complaints or fixtures (Storbacka, Windahl, Nenonen, & Salonen, 2013).

Today, the status quo in the industrial service business is largely characterized by "low tech, high touch." Few service operations processes are automated or professionally managed, and outcomes often depend on the human aspect. Service technicians arrive upon a customer request and perform initial problem identification

on-site, often having to come back later with the right parts to solve the issue. Even though remote access enables remote maintenance operations, low-tech service operations with a high number of human touchpoints still reflect a recurring phenomenon across many industries and geographic regions.

When a manufacturing company is then maturing to deliver more sophisticated services, physical and/or smart services, relationship models, as well as interaction frequency need to change. It consequently creates a sense of urgency for these firms, which we outline below.

1.2 Sense of Urgency

The transition of manufacturing companies to providers of complementary products and industrial services, or of solutions, changes the relationship with the existing customers from primarily reactive services to a more proactive service approach. Nurturing the customer relationship becomes a crucial activity in a service-oriented organization, as the higher focus on customer lifetime value commonly enables the company to achieve higher margins, increase existing customers' share of wallet, and extend the profitable solutions to new customers while increasing their market share and achieving greater economies of scale and scope (Rabetino, Kohtamäki, Lehtonen, & Kostama, 2015).

While the potential gains will seem convincing, many manufacturers lack the appropriate relationship concepts, engagement strategies, as well as marketing planning and monitoring tradition for it. As stated above, the most common approach to interacting with customers is still through key account management teams. With a predominant focus on price and value-in-exchange instead of on lifecycle cost and value-in-use, this may not be surprising.

When the value proposition is now changing to industrial services that demonstrate their highest value throughout the lifetime of a product, imagine a remote monitoring or predictive maintenance service; for instance, it imposes significant changes to the way the provider should interact with its customers.

To summarize the differences between a traditional product manufacturer offering physical services and a smart service provider, consider the following (Table 1) adapted from Hood et al. (2016).

The table shows a clear trend toward an increase of customer touchpoints, which extends to the time between the sales cases, due to the substantial change in value delivery. Figure 1 illustrates the approximated distribution of customer touchpoints over time.

The graph visualizes that even though digital technologies enable remote opportunities, the human touch gains importance as the number of interactions increases for smart services. Essentially, the relationship with the customer intensifies substantially (Rabetino et al., 2015). Smart service sales commonly require longer sales cycles and include more stakeholders. Moreover, selling smart services often involves a free trial phase involving intensive exchanges. Between the sales cases, it might be fruitful to carry out regular meetings to quantify the realized

Table 1 Comparison of a traditional manufacturer and a smart service provider

	Customer experience	Frequency of interactions	Context of interactions	Value
Traditional manufacturer	*Reactive*—To customer or partner inquiries and complaints	*Little to none*—Mainly at the time of sales or during service incidents	*Standard*—Sales or physical service cases	*Product*—The main features of the product or the physical service deliver the value (e.g., repair)
Smart service provider	*Proactive*—With an intentionally designed approach	*Continuous*—Ongoing dialogue, enabled (e.g., by digital platforms)	*Customized*—Purposefully designed depending on the customers' contingencies	*Service/data*—The insights gathered from the analyzed data become a major value driver

Fig. 1 Approximated distribution of the number of company-customer interactions. Own illustration

value of currently operated services. The latter option appears probable, as the customers' uncertainty about the effect of a smart service, taking again the example of a predictive maintenance service, is real. Scheduling regular meetings, where the manufacturer can give insights into detected events that were mitigated in advance, wherever possible connected with a rough calculation of a prevented loss, is a good means to alleviate the uncertainty.

Additional interactions are conceivable that include discussions about the currently obtained service portfolio or paid features of a single service containing multiple traits. Customers typically appreciate the proactive assessment of the paid features by the supplying company. The sales force might conclude that a particular customer is paying for something he does not use and consequently eliminate the feature from the next bill. Such short-time margin losses commonly turn into long-term customer satisfaction and loyalty.

Even though manufacturing companies might now anticipate the reasonability to professionalize their customer touchpoints, customers could be a problem too. Some might not want to engage in deeper relationships, as the supplying manufacturer only delivers non-core products or services. It may then be essential to think about strategies on how to teach the customer that a deeper relationship could be beneficial for both sides. In any case, the company should always integrate the customer's perspective already into the process of designing new customer interaction and engagement concepts.

1.3 Professionalizing Customer Touchpoints

Manufacturing companies that come from a tradition of long-term relationships with established customers may naturally transition toward increased customer embeddedness by fostering closeness to and interaction with the appropriate stakeholders (Storbacka et al., 2013). Fundamental for increasing customer embeddedness and a prerequisite for many kinds of services is trust. Trust within partnerships is crucial, as manufacturers would like to get data from and insights into customer actions that help understand the product performance and how the customer uses it. Manufacturing companies that proved to be a reliable business partner over time can build on the created trust. Otherwise, it can be a major challenge.

For instance, moving toward equipment-as-a-service business models (i.e., offers where equipment is not sold to but used by the customer for a negotiated purpose), time, and fee entails a raising intensity of the relationship with the customer based on trust to secure ongoing availability. Such business models appeal to many companies (consider the Hilti fleet management system[1] or the KUKA car-body-as-a-service concept for Chrysler[2]) but require extensive customer knowledge. Customer embeddedness is, thus, essential to pinpoint the problems and needs of the customer to create customized value propositions.

Maturing from offering physical services to smart services and maybe further to equipment-as-a-service business models involves a significant mindset change. Essentially, this change can be described by visualizing the transformation of value propositions, which are developed, sold, and delivered through a long-term process *with* the customer rather than *to* the customer (Storbacka et al., 2013).

To realize increased customer embeddedness, manufacturing companies may come up with an engagement strategy as part of their overall CRM concept. Acknowledging the opportunities given by digital technologies, platforms can be used to integrate the customer into various topics. The trend goes toward omnichannel presence to catch customer attention and touchpoints in any possible

[1] https://www.hilti.group/content/hilti/CP/XX/en/services/tool-services/fleet-management.html, Baumbach (2005)

[2] https://www.kuka.com/en-de/industries/solutions-database/2016/04/kuka-toledo-production-operations

way. Companies can then profit from data analytics to build customer profiles and enable the change from reactive to proactive customer interaction. Leveraging digital interaction models may even offer possibilities to scale back investment in sales and account management teams. However, it is more likely that these employees can benefit from the digital tools to ease exchanges with customers, increase their reach, or conquer untapped opportunities.

Self-service systems reflect one example of a digital engagement platform. Here, customers can access a one-stop customer portal to manage and order spare parts, see their order history, investigate instruction manuals, place warranty claims, inform themselves about new product generations, and much more. MyVoith[3] is one of these self-service systems for customers of the Voith Group that we see popping up recently throughout many industries.

The advantages are evident. Channeling customer inquiries enables faster reaction times, lower administrative efforts, lower susceptibility to errors, and better information sharing, ultimately leading to significant customer satisfaction.

With customer satisfaction being the breeding ground for trust and the consecutive willingness to embark on long-term contractual agreements in terms of smart service or solution offers, we found that companies and customers have a non-linear (i.e., circular) relationship. Customer satisfaction leads to trust. Trust leads to the openness to granting the supplier access to the required data to perform the defined smart services. Engaging the customer in the whole process and demonstrating the value of the service regularly lead to customer satisfaction, which again strengthens the created trust.

An elaborate CRM strategy containing the provider-customer interaction concept should, consequently, already be in place as soon as the first smart services are introduced to early adopters among the customer base.

1.4 Implementing CRM

In our view, CRM is mainly about managing customer relationships in an organized manner and focuses on leveraging and exploiting interactions with the customer to enhance customer satisfaction, in turn, securing financial returns and increasing customer profitability (cf. Bull, 2003; Gummesson, 2004).

Coming back to the findings of Payne and Frow (2005), implementing CRM means the development or adaption of business processes and the integration of IT systems. Concerning the process development, many manufacturers directly strive to go fully digital. Developing an online portal to channel customer interactions may benefit significantly from a reasonable analogous process mapping before elevating it into the cloud. Being clear about the underlying processes, inter-relations, and boundary conditions "on paper" can prevent developing a digitalized chaos. Creating a customer portal as part of the customer engagement strategy can already

[3] http://www.voith.com/corp-en/digital-solutions/myvoith.html

demonstrate a big pain point when not executed based on pre-defined lean processes and a sound approach to the integration of IT systems.

Manufacturing companies commonly already have a working portfolio of IT systems and customer data at multiple places that need to be fused. Specifically, the enterprise resource planning (ERP) system has a strong connection to the CRM system. Synthesizing both infrastructures could create major efforts. As many companies are aware of this, several try to use the ERP as long as possible for CRM-related operations. However, at some point, it is a reasonable choice to include a CRM provider in further development to cater for the interfaces between these systems. Often, this is time-consuming and expensive. It may, therefore, be a good idea to pay for expert advice in the early phases of CRM development to align the IT infrastructure carefully. Clarifying underlying business processes beforehand "on paper" might again be a valuable approach to prevent a head start into IT systems integration that prolongs substantially without the necessary preparation.

Apart from the technological challenges, CRM requires attention from an organizational point of view. Concerning the organizational integration, previous findings suggest that CRM is a multi-faceted phenomenon but part of the marketing strategy. Companies typically launch CRM initiatives from the marketing, sales, or service department, while the cooperation of at least these three units would be beneficial. However, as we concluded above, CRM pertains to multiple departments throughout the company, which implies that an organization-wide CRM strategy with clearly defined objectives should be pursued (Keramati, Mehrabi, & Mojir, 2010).

Launching a CRM program necessitates a clear project lead ensuring its purpose and functionality throughout every corner of the company. Measures for data maintenance need to be taken as it is equally imperative for the sales force and service technicians to keep the customer data up to date.

Moreover, the department in charge must define methods to increase customer embeddedness over a longer time horizon. We provided the example of a self-service system as a passive method to enable the convergence of customer touchpoints—passive in the sense that it still requires the customer to access the portal from his perspective.

An active method to enhance customer embeddedness as part of implementing a CRM strategy is, for instance, service coproduction or sometimes also called co-creation. It presents a suitable tool to infuse a service mindset within a technology-dominated organization (Rabetino et al., 2015). Service co-creation enables manufacturing companies to innovate services with the customer and hence merges innovation and sales activities. To execute a co-creation approach within the sales force, the company should be aware of the resource and competencies required for all related activities, including timely service delivery.

Siemens Mobility is a manufacturing company that excels in co-creating smart services with its customers, wherefore we encourage to investigate the respective case in Part II of the book.

Throughout the time of continuous service delivery, the number of customer touchpoints is likely to decrease, but manufacturing companies should find ways of creating a regular exchange. Digital channels provide efficient interaction models,

while quantification meetings (as outlined above) and manifold other customer events could be ideated and executed as part of the CRM strategy. Here, the leading CRM department must provide options for maintaining the customer relationship for the entire organization.

2 The Evolution of Company Collaborations

Doing business can be understood as a network of relationships. Companies receive material or goods from suppliers. They may get advice from consultants. Many firms count on opinions and support from experts. A company can have one to multiple development or service partners. Distributors or agents may sell their products, and customers use them. While this enumeration is not conclusive, Teece (2010) describes a business model as an externally oriented description of the relationships a company has with a variety of actors.

Most traditional value chains at manufacturing companies will change or already have changed to a constellation forming a network rather than a chain. Business strategists have already elaborated on this topic for some time, but in slow-moving industries with long-lasting product lifecycles or strict market regulations, the changes come with reduced speed.

The intensified focus on core competencies in the last decades naturally forced manufacturing companies to deal with multiple partners contributing to the final product. A similar development takes place for organizations that now embark on the servitization journey. Servitization means integrating the contributions of a network of actors to create customer value, but the characteristics of the network and the challenges for the orchestrator differ whether a manufacturer operates with a direct or non-direct sales approach.

Therefore, we elaborate on the changes for companies concerning the following six dimensions depending on their sales approach in the subsequent paragraphs:

- New and existing partner involvement
- Redefining service delivery
- Financial flows
- Data flow, data access, and data ownership
- Customer access
- Vulnerability to new entrants

2.1 Manufacturers with Direct Sales

Companies that have direct customer contact may have fewer difficulties in transitioning to a value network providing smart services. Close customer relationships built on trust can enable the manufacturer to cope with the changing situation and influences inherited from the introduction of smart services.

2.1.1 New and Existing Partner Involvement

Firms may redefine themselves from a producer of goods to a provider of a complementary portfolio of products and industrial services or of further solutions (Storbacka et al., 2013). It may indicate that the company has to cooperate with formerly unknown partners for data-related matters. Depending on the make-or-buy assessment the manufacturer conducted at some point throughout the servitization journey, it is likely that the company concluded to partner with specific service providers, software or other tech companies, and startups. It is a common approach to seal new partnerships with companies or even acquire startups that excel in capabilities not found within the manufacturer. For instance, to build the customer portal MyVoith, which we introduced before, Voith first partnered with the digitalization agency Ray Sono[4] and then acquired 60% of the company.[5]

Enlarging the organizational network by connecting to additional partners or by strengthening bonds with existing partners entails various advantages and drawbacks. The advantages focus primarily on the ability to combine the knowledge and capabilities of the different actors. Each participant supports the network with its core competency and shares the required information.

Drawbacks embrace the increasing complexity to manage the new variety of partners and to leverage the appropriate capabilities internally. Necessary capabilities may include the possibility to perform solid requirements engineering for new software products, such as a customer portal, without being highly dependent on third parties.

2.1.2 Redefining Service Delivery

One aspect that could have a more severe influence on the value network of a manufacturing company is its strategy for service delivery. In a situation where a company is close to the customers by having local service and sales units, the manufacturer should contemplate the approach for smart services. The question is whether the smart service should be delivered centrally or locally. For instance, it may be fruitful to split the activities into backstage and frontstage processes. While the data could be fed back to a central data repository, the physical service job can then be executed by a local service technician.

With a central database, the algorithms can unfold their potential to process big data, and software engineers may improve the algorithms due to a higher input variety. It may further create worthy insights for product and service development, reduce administrative cost, and foster standardization. Once the processed data exceeds predefined thresholds or any other negative event occurs, the central operations center triggers the corresponding service activity from the regional subsidiary.

However, country or customer regulations may hinder the transmission of the data from its origin to the central repository located in another region. Manufacturers

[4] https://www.raysono.com/raysono/references/voith

[5] https://www.raysono.com/raysono/stories/gemeinsame-digitalisierung-der-industrie-mit-voith

may further ensure that issuing the triggers on time does not depend on the working hours of the operations center.

Service delivery may consequently change compared to established processes when introducing smart services (cf. Chap. "Service Operations" for details).

2.1.3 Financial Flows

As manufacturing companies have a direct connection with the customer, in this case, the financial compensation for delivering smart services is unlikely to change and flows immediately to the provider. Here, shares of this compensation may be split between the manufacturer, a data analytics partner, the cloud provider, and other potential stakeholders.

2.1.4 Data Flow, Data Access, and Data Ownership

Offering smart services will require firms to examine adaptations to the governance structure with a special focus on data-related issues. Receiving access to the data is still a highly relevant challenge for many manufacturing companies, even though they follow a direct sales approach. This means, when companies convince their customers to receive their data by promising value in return (e.g., by providing valuable smart services), regulations about how the information is transmitted and who owns the data must be in place.

Manufacturers can negotiate individual conditions regarding whether the customer allows a continuous connection, or the data is only transferred batch-wise. Here, a compromise has to be found, including the customers' security regulations, infrastructural limitations (e.g., sampling rate), and the necessary input for the functioning of the service.

2.1.5 Customer Access

Acquiring insight from customers carries tremendous importance for various positions within the company, which is why we elaborated on possible (digital) customer engagement strategies to increase customer embeddedness. For manufacturing companies that rely on a direct sales approach, it should be less of an issue to get customers involved. As sales and service employees already have a personal connection to many customers, they are in the pole position to strengthen the relationship.

2.1.6 Vulnerability to New Entrants

Enabling the products to create data through a diversity of sensors paves the way for third parties to directly dock on the manufacturers' customers. Third parties are principally in the same position as the manufacturer to convince the customer to share the generated data with them. Startups and other tech companies could leverage their greater agility, data-savviness, and proficiency, as well as the resulting superiority against the manufacturer to seal the deal.

Some manufacturing companies may encounter the threat of third parties connecting directly to their end-customers by creating closed systems or lock-in effects. Opting for such possibilities may, though, lead to customer dissatisfaction or

provoke disharmony. Hence, companies should balance whether they have the right position and opportunity to do so.

In general, we experienced that working with open systems increases transparency and shows confidence in their own abilities. Manufacturers repeatedly emphasize not feeling intensive pressure from third parties in this scenario as the new competitors lack the specific product and domain knowledge to provide actionable insights from the data. Highlighting significant events within the data only becomes valuable when related to the corresponding hardware or mechanics in the system.

Consider the following example to illustrate the discrepancy between data insights and valuable information. A company producing agricultural and construction machinery once contracted a data analytics provider to examine the data captured from several identical machines to detect irregularities with the impetus to learn from the data and to improve the product. The analysts came up with a highly significant event in which at any moment a particular action was executed, the system triggered a plethora of error codes. They concluded that to eliminate the actuation of the error codes, the trigger event should be avoided. The manufacturer then discovered that the trigger event the analysts detected was the start of the engine. Here, the system released error codes, such as "no fuel pressure" because the pumps kicked in with a short delay after the engine start. Eliminating the engine start is, however, not a feasible option.

The result exemplifies that insights from data should always be translated into valuable information. The same accounts for all industrial services, wherefore manufacturing companies that have direct sales can profit from the direct customer access and play to its strengths.

2.2 Manufacturers with Indirect Sales

Contrary to the limited number of changes concerning the selected dimensions for manufacturing companies with a direct sales approach, the drawbacks can be potentially significant for those not having direct customer contacts but still want to play in the field of smart services (see Fig. 2 below). Thus, when manufacturers advance toward smart service provision, tensions and conflicts of interest may arise. Yet, we need to differentiate between exclusive and non-exclusive distributors in the following.

2.2.1 New and Existing Partner Involvement

In principle, all mentioned aspects regarding new partner involvement for manufacturers with a direct sales approach are equally relevant for companies relying on distributors. The main addition concentrates on the significant and even increasing value of the distributor.

A transaction-oriented business with a focus on value-in-exchange (as with hardware products and physical services) can work well as distributors only need limited selling capabilities. In the best case, the products stand for themselves, and distributors come into play when basic maintenance or spare parts are required.

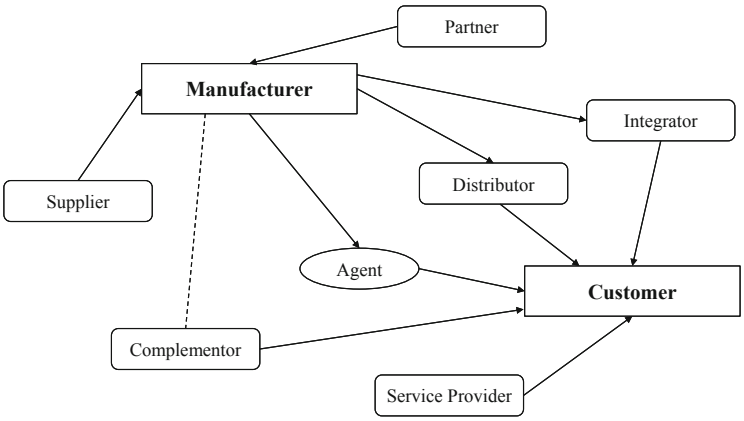

Fig. 2 Example of a value network with channel partners. Own illustration

Operations are easier to standardize and more transferable to distributors. For smart services, however, a consultative selling approach necessitates profound, detailed knowledge and the capability to explain every characteristic, interdependency, and consequence. Distributors receive much more responsibility as the importance of the sales force increases. Not only do distributors and their personnel now have the duty to sell more complex offers but especially to leverage customer embeddedness to capture valuable customer insights.

From the manufacturers' point of view, the activities shift from engaging the customer to enabling the distributor for selling and delivering smart services, as well as to capture and transfer customer information. Consequently, increasing partner embeddedness is not only vital to enable the distributor but also to strengthen links in particular with non-exclusive dealers.

Digital platforms can again support fostering partner embeddedness. Partner relationship management platforms could provide relevant delivery information for the channel partners and end-customers in a reliable and timely manner, decrease sales and administration expenses, shorten sales and support cycles, as well as build consistent customer experience quality among different channels (Hood et al., 2016).

2.2.2 Redefining Service Delivery

For manufacturing companies that rely on distributors for sales and service operations, defining processes for smart service delivery can either be similar to the challenges stated above or even more complex due to the integration of an external organization into the process.

We can argue that whether a manufacturer has to include a local subsidiary or a distributor into service operations does not change a lot. To ensure the ongoing availability and functionality of the smart service, the manufacturer must define a coordinated plan involving a data operations center, the distributor, and the customer. Service delivery is, thus, tightly interlinked with the data and information flow discussed below.

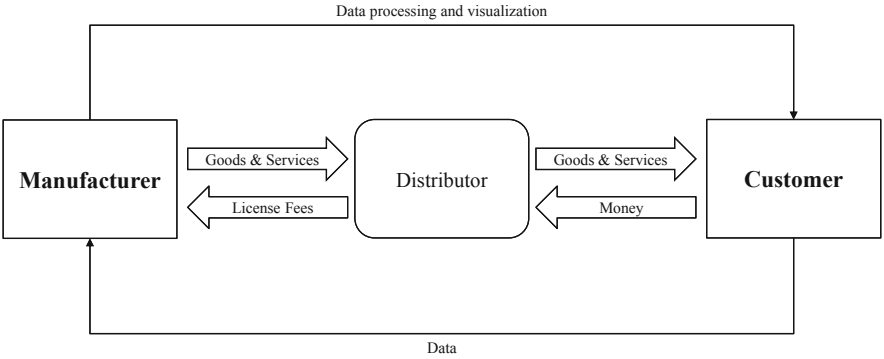

Fig. 3 Visualization of product, service, financial, and information flow between the manufacturer, the distributor, and the customer. Own illustration

Consider Fig. 3, which illustrates one feasible possibility to deliver smart services with distributors. It shows that while the flow of goods and industrial services goes from the manufacturer via the distributor to the end customer, the recipient directly links the data to the provider and receives the corresponding outcome in return (e.g., reports, visualizations, etc.).

Bypassing the distributor is in most cases not a sustainable option in service delivery, as the distributor might step back from selling the manufacturers' products and services in the future or strives to inhibit the data connection between the manufacturing company and the customer. Instead, enabling the distributor with a clear idea of how he can directly benefit from this development is imperative.

However, it strongly depends on the individual constellation of a manufacturer's network and which opportunities it has concerning the smart service portfolio and service delivery. Previous findings suggest that servitization endeavors need to be tailored to the position of the company within the value network and the importance of the products to the customer (Bustinza, Bigdeli, Baines, & Elliot, 2015).

Voith Turbo is only able to showcase its predictive maintenance solution since it aims to interact with the end-customers of its automatic transmission unit. Even though the product is typically shipped to and installed by the OEM of the vehicle, Voith sells the service directly to the private or public transportation operator. Yet, the automatic transmission unit is one of the most important parts of the vehicle and a major cause of unplanned downtimes. The bus operator has, thus, a legitimate interest in talking directly to Voith.

In this case, the OEM might be an integrator instead of a distributor, but Voith has the ability and power to bypass the OEM. Many manufacturing companies that operate with a network of distributors are likely not to have this power.

The position of the company within a network and the importance of the product for the customer, thus, determine the information the company can capture from real users of the products, in turn, scoping which services it may offer, how it should redefine the service delivery, and which competitive advantages it can achieve.

2.2.3 Financial Flows

Figure 3 indicates that the financial flow could be split into two streams. While the manufacturer might demand a fixed fee for software licenses or each specific smart service, the distributor has certain creativity in negotiating the pricing strategy with the customer. For instance, for each machine profiting from a predictive maintenance service, the manufacturer receives EUR 200 per month, while the distributor and the end-customer agreed on a total price billed once a year.

Yet, the manufacturer should propose pricing plans for their distributors to enable a reasonable harmonization across the final price level.

2.2.4 Data Flow, Data Access, and Data Ownership

Similar to manufacturers with a direct sales approach, firms, in this case, have to define a clear governance structure with a focus on data-related issues. The additional complexity stems from the moderating role of the distributor. Here, the distributor needs to take up the task of negotiating feasible conditions for data access in combination with company and customer regulations, despite not being immediately concerned with data transmission.

2.2.5 Customer Access

Manufacturing companies in a network where customer access is limited—due to products being primarily sold through distributors—could be in a vulnerable position for several reasons. Customer interaction, especially customer integration, may be widely limited or impossible due to the intermediary, who receives greater bargaining power as the provider of the smart service is highly dependent on complete customer insights. The customer or the intermediary may prevent data sharing directly to the manufacturer, wherefore certain smart services could not be offered at all.

Manufacturing companies that operate with exclusive dealers or which have established a solid and trustful partnership with non-exclusive dealers may not encounter the same challenges and drawbacks. Good partnerships can offset the vulnerable position of a manufacturer without direct customer contacts. The CRM strategy might slightly adapt to foster not only the customer but also partner embeddedness. John Deere proves impressively, for instance, that having direct sales is not a prerequisite to be successful with smart services. Their activities just change to enabling the distributor, compared to any other company not selling through an intermediary (see the John Deere case in Part II of the book).

We already expressed the possibility of implementing a partner relationship management program to receive indirect customer access by increasing partner embeddedness. Consequently, manufacturing companies can find creative ways of capturing customer information by cooperating with distributors. For example, joint workshops of the company, the dealer, and the customer could be possible ways of adapting the aforementioned co-creation process. In any case, the manufacturing company has to keep in mind that it needs to design a smart service reaching a win-win-win situation. Distributors need to benefit directly from offering smart services

for the OEM, which also requires that the necessary investment the distributor needs to make should be compensated over the short or long term.

2.2.6 Vulnerability to New Entrants

When manufacturing companies have weaker bonds with the end-customer due to the intermediary, new entrants may demonstrate an even greater threat of docking directly to the customer by promising process improvements or other services based on the data transmitted from the OEM's products.

Third parties may still be limited in the significance of their service outcomes, wherefore manufacturers have to mitigate the increased risk of new competitors by increasing partner embeddedness, as we concluded before.

Consequently, when a manufacturing company obtains a non-ideal position within a network, it should focus even more on its strength to combine the provided services with domain and product knowledge, as well as the asset to offer a complete, complementing, and compelling portfolio. But recognizing the impact of the distributor and defining the challenges that ensure are vital activities for the manufacturer. Notably, when manufacturing companies find ways to strengthen bonds with the distributor and let him profit from introducing smart services, the distributor has an intrinsic motivation of winning against new competitors. Enabling the distributor may, thus, lead to a beneficial partnership for every participant of the value network.

3 Managerial Implications

Professionalizing the CRM is the way to go for manufacturing companies that move forward in the servitization journey. Customer inputs are crucial for service-related operations, and customer-centricity is important for the whole company, even though it somewhat opposes the technology fascination within the engineering department. Infusing the service mindset is, thus, a great challenge.

Practitioners can implement a variety of passive and active measures to enhance customer embeddedness. Self-service systems or one-stop platforms could increase customer engagement. Introducing a co-creation approach intensifies the customer involvement in the service development and sales cycles.

Essentially, manufacturing companies should find ways to engage more with the customer and manage customer touchpoints meticulously. It means that companies should prepare, execute, and learn from customer encounters. Showing customers the increased value of their position could result in appreciation, but a company should not show vulnerability (i.e., dependency), leading to the higher bargaining power of the customer. Instead, emphasizing the mutual development character may strengthen bonds.

Employing a CRM system to professionalize the customer relationship also means making use of the data to increase efficiency and leverage economies of scale and scope. Fusing databases and capturing customer information are not sufficient when a company does not strive to create valuable insights from

it. Therefore, the data can be used to create customer profiles, improve service offerings, and perhaps modularize services to decrease the required customization efforts and increase economies of scale.

The type of industrial service offering further depends on the companies' role in the value network. Therefore, the manufacturer should examine its position, describe strengths and potential risks, formulate mitigation strategies, as well as cycle the information to the service and/or corporate strategy development. The question is, which position does the company want to have, and what does this mean for the servitization journey?

Once the company is clear about the position and what it wants to achieve, it can focus on partner or customer embeddedness (depending on a direct or non-direct sales situation) by applying digital collaboration platforms or further means.

4 Summary

While manufacturing companies could previously rely on solid engineering capabilities to reach their customer base, simply providing high-quality products is not enough for servitization endeavors. The customer relationship evolves from reactive transaction-based value-in-exchange to proactive, continuous collaboration and value-in-use. Introducing advanced industrial services successfully depends on the ability of the provider to process information and insights from the customer. But first, the company needs to acquire this information and these insights.

There are multiple ways to interact with customers passively and actively. In each way, the company should manage customer interactions wisely. When the manufacturer has problems receiving direct customer input due to an intermediary, it should focus on enabling the channel partner to deliver the necessary information by increasing the partner embeddedness and organizational networkedness. The firm should be clear about its position in the value network as it affects the service strategy and industrial service portfolio. But no matter which position a company may have, want, or strive for, there are always opportunities to be successful. Just the challenges and activities will differ.

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Outlook and Summary of Managing Industrial Services

Philipp Osterrieder and Thomas Friedli

Wars may be fought with weapons, but they are won by men.
General George S. Patton

The first part of this book covered the current state of the most relevant topics concerning industrial service management, intending to provide an encompassing perspective for both academia and practice. In the spirit of the renowned St.Gallen School, we put some emphasis on the managerial implications, providing guidelines for interested managers to define their specific approach for professionalizing the industrial service management in the areas of service strategy, organizational structure, service innovation, service sales, service operations, CRM, and value networks. However, to be successful in the long term, it is all about culture and leadership. Before we start with the second part providing insights into selected real cases directly contributed by service managers, we take a glimpse into the future of industrial service management and conclude with a summary condensing the main findings of the first chapters.

P. Osterrieder (✉) · T. Friedli
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: philipp.osterrieder@gmx.net; thomas.friedli@unisg.ch

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1 Gaining the Future

We focus the examination of potential avenues for future developments, both necessary and likely to happen, on the subjects of service strategy, organizational structure, service innovation, sales, and operations, as well as on CRM and value networks.

1.1 Service Strategy

Service strategy depicts the area that received most attention from both researchers and practitioners in the past. A strategy typically should come first, which is why this subject raised the concern of most involved people. Consequently, the process of strategy definition is already well-understood and correspondingly described. While we advanced the current state of research with practical insights from the specific needs of manufacturing companies venturing into the provisioning of physical and smart services, it is nevertheless evident that several tools and approaches stem from traditional management theory.

Following this idea, future developments might include the further specification of strategy traits, content, and methods concerning smart services at manufacturing companies. Even though we strongly believe that the dimensions of a service strategy and the necessary analyses to fill these with purposeful content described in Chap. "Service Strategy" illustrate what professional industrial service management requires, we see the potential to further specialize them in the area of smart services.

1.2 Organizational Structure

Similar to the service strategy, academia and practice strove to find appropriate organizational configurations for providing physical services, while the topic of smart services has only recently been approached. We filled the gap with action-based research in the last years and developed potential configuration possibilities together with manufacturing companies. As the typology incorporates very recent findings, the practical application of the diverse structures needs still to be proven in the future. In particular, the long-term sustainability of the types should be examined together with the industry.

It is crucial that companies look into potential structuring alternatives depending on their contingencies early in the process of advancing toward smart services as the right or wrong organizational design can either promote or hinder success. Yet, it can be an appropriate method to start with a flexible design in the beginning and evaluate its suitability on a regular basis. Together with the constant organizational development of manufacturing companies, the specific types and their peculiarities should be revisited in the future.

1.3 Service Innovation

Today the greatest challenge for manufacturing companies is to structure service innovation to improve the performance of future service offerings. Once an appropriate framework exists and is widely applied, new challenges will arise in service innovation for manufacturing companies. Within the overarching framework, there are still some white spots that have to be defined to be successful in service innovation. Manufacturers need to define an adequate selection mechanism applicable in the early innovation phase to ensure the choice of the most promising ideas. A business case template for services would add to this selection mechanism as this would include not only potential benefits but also the expected costs to develop the service. Subsequently, customer experience design is a very mature discipline in B2C contexts. However, tools and methods still have to be adapted or designed to develop appreciated customer experiences in a B2B environment. Customer experiences are more complex in terms of the number of involved stakeholders and their duration over time. Service developers have to consider different boundary conditions that finally call for new approaches to develop customer experiences in B2B. Moreover, the trend of combining the value proposition of products and services keeps evolving. We, therefore, expect that innovation activities of products and services have to be further aligned. Overall, new offerings, like equipment-as-a-service, increase the pressure on manufacturing companies to offer continuously new service features during active equipment-as-a-service offerings. Such offerings again require new service innovation processes that need to be implemented into the organization of manufacturing companies. Furthermore, related role profiles have to be defined clearly as well. In most cases, the allocation of responsibilities is rarely free of conflicts. Chiefly, manufacturers can only accelerate service innovation if responsibilities are clear to all stakeholders. We, therefore, emphasize the relevance of implementing service innovation comprehensively.

1.4 Service Sales

Most smart services launched in the market by the beginning of the 2020s offer functions to monitor assets remotely and trigger intervention in case of imminent failure. Still, our research reveals that preventive features are largely underdeveloped. Data collected from the installed base are insufficient to allow for fine-coarse analysis of failure patterns and timely anticipation of breakdowns. Manufacturers with a clear roadmap for smart services will set the right strategy to penetrate the markets in the short term and earn income in the long term.

As service digitalization advances, sales approaches need to keep track. The more software-infused services become, the more their market success becomes dependent on the manufacturer's ability to release new functions over the product lifecycle. This requires sales managers to foster even closer cooperation with customers. The key to customer satisfaction and profitability is, therefore, a sales force that can, first, recognize expressed and latent customer needs; second, tailor a service package that

reconciles value creation and value capture; and, third, remain in frequent interaction after the initial sale to enable customer success in the long run.

1.5 Service Operations

The tasks and challenges of service operations management have always been evolving, and they will continue to do so in the future. Nonetheless, three selected avenues deserve further attention.

First, whereas physical service, smart service, and product business have been separated over the years, there are many reasons to believe that this development will be reversed in the future. For the customer, the entire value provided will be a decisive factor rather than single products or services, leading to a progressing merge of both offers. As the number of outcome-based contracts and equipment-as-a-service models will increase, the ability to react quickly and proactively to unforeseen events is becoming increasingly important for the service operations organization. It is, thus, important to get started and to develop digital capabilities, update processes and the infrastructure, qualify employees, and establish a service excellence culture.

Second, long-term agile thinking and acting become a crucial necessity for staying competitive. It includes establishing close cooperation between service operations, innovation, marketing, sales, and corporate management, but also a cultural mindset change with the customer at its center needs to be developed.

Third, the human touch will not decrease in its importance for the service operations organization. Contrarily, it will continue to become more and more of a key differentiator. Customer interactions may be digitalized to some extent, but they are increasing, requiring skilled personnel able to deliver real value. Importantly, the knowledge and skills of today must be maintained in the organization and also be made available in the future.

1.6 CRM

So far, we have seen only a few manufacturers that apply a sophisticated CRM system across the entire company. As customer information is likely to (and must!) increase in the future to direct service innovation and sales endeavors, companies are required to invest in the implementation of a thorough CRM system. Recent systems already provide a plethora of functions manufacturers can benefit from in their day-to-day activities. While it is almost certain that companies like Salesforce.com or SAP will not stop to further develop their offers, manufacturers should instead care about the integration and adoption of such systems within their employee base. The best technology does not pay off if the personnel is not using it. Promising avenues from a management perspective should, therefore, focus on leveraging the technology-enabled potential within the company. Leadership issues could be raised at this point or the necessary changes in training and incentive schemes.

1.7 Value Networks

The advent of digital technologies required manufacturing companies to collaborate with further partners to bring in software-related capabilities not needed in the past. While this evolution creates notable opportunities for companies to cooperate with flexible and innovative startups enabling formerly unimaginable offers, new entrants could use the generated data for offering competing services.

In Chap. "Customer Relationship Management and the Value Network," we focused on the importance of the intermediary in case a manufacturer does not apply a direct sales approach. While it will create valuable insights to investigate value networks with a focus on manufacturing companies providing smart services in general, an important issue to examine depicts the role of the intermediary between the manufacturer and the customer within the value network. Providing guidelines and tools to increase partner embeddedness is of the highest value for manufacturers that rely on their dealer network to receive vital data from the customers.

2 Summary

After the introduction, we described in Chap. "Servitization of Manufacturing Companies" that today most manufacturing companies find themselves in some sort of a transition phase. Few companies still need to establish their physical service business, whereas most manufacturers are on the brink of providing smart services. The emergence of digital technologies and their accelerating development combined with decreasing costs for sensors, actors, and cloud space enables new compelling solutions based on hardware, software, and data. Embracing this change and venturing into the field of smart services is, for most manufacturers, inevitable to stay competitive.

However, we warned not to fall for the service or digital paradox, which is why companies should be concerned with establishing the right processes and infrastructure with the right people to tackle the challenges imposed by the introduction of smart services. To be successful with industrial services, manufacturers have to break to some extent with their heritage of only focusing on producing superior goods when it comes to innovation, sales, or operations approaches. This includes cultural change. Industrial services require different methods, values, attitudes, and capabilities. To channel the rising complexity, companies have to establish professional industrial service management along the following dimensions: strategy, organization, innovation, sales, operations, CRM, and value networks.

Chapter "Service Strategy" explains that the service strategy must be aligned with corporate objectives to reinforce the corporate strategy and the overall company's mission and vision. As we showed, strategy formulation is a process based on inputs from top management on the one hand but especially from detailed analyses on the other hand. Internal capabilities need to be examined just like customer needs and market trends. Together with the results of further analyses, the information

culminates into the definition of the five dimensions of a service strategy: the objectives, the USPs, the portfolio, a make-or-buy evaluation, and the roadmap.

Next in line is the structure of the service organization discussed in Chap. "Organizational Structure." Due to the large independence of the product and physical service business, the majority of manufacturing companies opted for a separate service organization. Specificities of smart services arising from the necessary closer collaboration of product, software, and service development departments now suggest questioning the dominant structure. Additionally, we explained that not only one optimal structure exists as it depends on the individual characteristics, context, and strategy of a company. We solved this issue by proposing eight different structuring possibilities companies may examine for their distinct purpose.

Consecutively, the three core value chain processes, namely, service innovation (Chap. "Service Innovation"), sales (Chap. "Service Sales"), and operations (Chap. "Service Operations"), have to be revised to create a sustainably successful service business.

Considering the first part, manufacturers often demonstrate inefficiencies in service innovation as they repeatedly adopt ad hoc approaches triggered by customer inquiries. A systematic service innovation process will, hence, create a higher probability of success. It is especially important to focus on the early phase to generate meaningful service ideas that will be developed further. Here, the customer is a key partner throughout the entire process.

Adapting the sales organization is another crucial step. Many companies have substantial problems in selling their services today (for a price greater than zero), which is why they should invest in service sales capability development. New service offers require a dedicated market strategy that provides the appropriate context for defining bundling options, revenue models, pricing, and sales channels, for which new capabilities are necessary. Moreover, the sales organization needs a suitable structure with robust, underlying processes and new roles to be successful.

The last part of the value chain concerns service operations, a field that received the least attention in research and above all in practice so far. Yet, as operations also directly interface with the customer throughout a major share of the product and service lifecycle, it is no less important. We explained that a well-organized and managed service operations organization could have a distinct influence on customer experience and satisfaction, as well as it shows great opportunities for the application of digital technologies. Even though the accompanying challenges can be severe, we concluded that manufacturers should start sooner rather than later to transition toward digital service operations.

As part of further enabling activities, we proceeded with the discussion of CRM and value networks in Chap. "Customer Relationship Management and the Value Network." Generally, we emphasized the crucial importance of customers at several points throughout the book, whereby we strongly advise companies to invest in professionalizing their CRM system. Not only is the information system vital to reach higher efficiency, but the entire management system of collecting, storing, and processing customer data also have to be revised. Since the relationship between company and customer evolves from reactive, transaction-based value-in-exchange

to proactive, continuous collaboration and value-in-use, the CRM at manufacturing companies has to grow likewise to remain competitive.

Another aspect that is changing concerns the way value is created. Today, it resembles more of a network than a chain, with each member contributing his share. Even though it describes a positive development in principle, evolution holds challenges, especially for manufacturers not having direct sales. A good intermediary is a strong partner with a decisive influence on the customer relationship, which is increasingly crucial for providing smart services since digitally enabled services still require physical interaction to strengthen bonds and build trust. We explained, however, that smart services open up the unfavorable possibility for new entrants and startups to dock on the customer directly. Manufacturers should, therefore, emphasize customer and partner embeddedness, respectively.

To conclude, this book provides a compelling collection of research- and practice-based insights synthesized to offer guidelines for the purpose of professionalizing industrial service management. We developed this book as we felt the progress in each critical area reached a certain maturity allowing us to share successful practices.

Part II

Insights from Practice

Editorial to Managing Industrial Services: Insights from Practice

Thomas Friedli and Philipp Osterrieder

After having provided a comprehensive overview of the management of industrial services in general and of smart services in particular, we move our attention in this second part of the book to selected case studies from the real world. These cases shall help the reader to even better understand success factors and challenges when striving to make a business with services. All cases are written by contributors from practice to ensure authenticity and depth.

In the opening chapter, Heidelberger Druckmaschinen, a pioneer in the digitalization of services and supply, summarizes her journey from more than a decade in a comprehensive narrative culminating in the derivation of four takeaways covering the way to start the journey, namely using lean start-up teams and agile methods, putting customers in the center, mastering the technological challenges, and intentionally managing resistance. It is just stunning how Heidelberg managed to link over 13,000 customer presses in her IIoT platform, the Heidelberg Cloud.

Schindler, one of the leading global producers of elevators, escalators, and moving walkways—and for years a role model for an outstanding service orientation—focuses her contribution on the human factor and limits to a full digitalization approach. Based on a rich history and deep experience, the authors make clear that the future will not be shaped by technology alone but that there is a need for the purposeful combination of the latest digital technologies, sound processes, and human expertise. This chapter brings the human factor back to the center stage.

John Deere describes what was needed to enable her Dealer Network to successfully deliver smart services. In a comprehensive analysis, the author does not only provide insights into John Deere's strategy and the role of after-sales service innovation in this context, but he also explains the organization, characteristics of the operating processes, cultural challenges, and the importance of visible management commitment and outstanding service quality. This chapter is an impressive

T. Friedli (✉) · P. Osterrieder
Institute of Technology Management, University of St.Gallen, St.Gallen, Switzerland
e-mail: thomas.friedli@unisg.ch; philipp.osterrieder@gmx.net

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account of the high maturity John Deere has already achieved on the way to a smart technology company but still building on highly reliable agricultural equipment.

SKF, a Swedish producer of bearings, adds an impressive story describing the way from an equipment manufacturer to a customer-centric provider of true solutions improving end-user productivity as well as energy efficiency. Along this journey, SKF changed her business model toward an "equipment-as-a-service" model. SKF provides insights not only into the successful use of artificial intelligence and condition monitoring but also describes hurdles they had to overcome.

Siemens Mobility adds a customer co-creation perspective as a means to drive and scale digital services to the book. An elaborated framework guides the co-creation process. The benefits of the application of this framework together with the customers, namely, customer-specific services, the engagement and commitment achieved by integrating the customer, better productivity and service quality, as well as reduced risks, heavily outweigh the challenges that are nevertheless also described in this chapter.

Part II concludes with the case of Kaeser, a producer of compressed air stations. The author describes the application of a digital twin for the automated planning, design, control, and analysis of these air stations. It is crucial to think this through over the whole life cycle of the compressors. The added value, if applied correctly, is considerable.

Industrial Smart Services Facilitated by the Heidelberg Cloud

Tom Oelsner

1 Introduction

Heidelberger Druckmaschinen AG is the leading manufacturer of sheetfed offset printing presses, the most important technology in industrial printing. With annual sales of approximately 2.5 billion Euros in the 2019–2020 fiscal year, Heidelberger Druckmaschinen is represented in 35 countries by its sales and service units (SSUs). In addition to printing presses, Heidelberg also sells all equipment for the modern print shop from prepress to postpress, as well as industry software. As a partner to the print media industry, Heidelberg provides lifecycle services in addition to the equipment business. These services include technical services ranging from installation, maintenance and repair to the retrofitting of machines. Heidelberg is also supplying customers with consumables for all aspects of industrial printing. The lifecycle business now accounts for around 50% of Heidelberg sales.

1.1 Industrialization Changes the Print Media Industry

Within the last 30 years, the production of printed products has developed from a family business, which was mostly handicraft-based, to industrial production. Digitalization has been taking place in this sector since the early 1990s and began with the complete conversion of the pre-press stage to computer-to-plate (i.e., the digital exposure of printing plates). For smaller and personalized runs, digital printing is becoming increasingly important. This is all happening under the sign of a constant printing volume worldwide, with the printing palette shifting away from advertising material and brochures to the ever more elaborate packaging. Today, a modern printing plant has a production volume many times greater than that of recent

T. Oelsner (✉)
Heidelberg Digital Unit, Wiesloch, Germany
e-mail: tom.oelsner@heidelberg.com

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years, is operated in three shifts, and requires the highest level of machine availability.

2 Pioneering the Internet of Things

Heidelberg introduced the networking of printing presses via the Internet back in 2004. Why did we do so?

A press machine is a piece of high-tech equipment. More than 1000 sensors ensure the proper operation of the machine. The repair of such a high-tech vehicle in combination with local software installations became harder and harder. In 2004 the on-site intervention index per service case was at 2.8—in other words, a technician had to travel 2.8 times on average to fix a problem. The first visit was usually required just to clarify the faulty parts. A second visit was scheduled within 24 h to fix the issues with the delivered part. If something went wrong, another visit became necessary.

The original idea of a remote service network had a strong business case: If we were able to do the parts clarification remotely, we could save more than 10 million Euros per year and increase the machine availability significantly. Today, quick response times with a high first-time fix rate are no longer possible without a global IoT solution. This idea was at the origin of the Heidelberg Cloud, which is the largest Industrial Internet of Things (IIoT) network in the print media industry today.

In addition to the technical benefits of this remote diagnosis and instruction option, the new approach marked a milestone to build trust in the customer relationship for the lifecycle services of Heidelberg. Even in 2004, there were concerns about data privacy and IT security, which reduced the acceptance of such a remote service.

Hence, we decided to integrate a "personal touch" in our remote services (see Fig. 1). If a technician accesses a machine for diagnosis reasons, the customer must approve the remote access case by case. As a result, the customer stays in control of the process. Once the connection is established, we transfer the name and a picture of the technician to the machine desk. Usually, our technicians work in a rotating model—provide some on-site service and serve some days at the remote back office. The operator typically knows the technician in person, and a trusted relationship can be continued over the remote session. In complicated cases, a third-level expert must support our service engineer in the country. Executed through a conference call, the local technician stays in the session and mediates between the customer and the third-level expert. Additionally, it was the best remote training approach we ever developed. Local technicians learn case by case from our third-level experts helping the customer together remotely.

Although the service was now a remote service that allowed parts clarification and partly a remote fixture of electrical issues, as well as remote guiding of operators (it was still a reactive service), the customer had to call Heidelberg after a machine breakdown.

Fig. 1 Trusted customer relation: personalized remote session and over-the-shoulder support. Own illustration

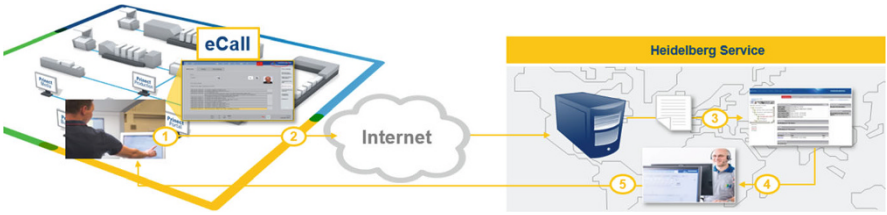

Fig. 2 eCall®—The first proactive, digital service model. Own illustration

The logical next step to achieve a smart service was the eCall® system invented in 2008 (cf. Fig. 2). It is the first proactive service approach in the industry. We realized that in case of a machine breakdown, it took the customer, on average, 30 min to pick up the phone and inform Heidelberg. Usually, the customer tries to fix the issue by rebooting the machine before calling Heidelberg. Often, this behavior wastes time. Since the machine is already connected, why not let the machine send the information about the service issue and open a service incident message at the Heidelberg help desk automatically? Establishing the eCall® approach changed our customer relationship radically. Before eCall®, our help desk was the first (reactive) contact point. The customer was emotional and angry when calling and provided the incident details verbally. Often, we encountered statements like: It is the same as last time. You can train your call desk personnel for this kind of situation, but it will always remain stressful. Essentially, it will not be getting better until you provide a real proactive approach.

With eCall®, the machine is calling Heidelberg on its own and sends all diagnosis data within the same message. A trouble ticket number is replied in seconds to

inform the operator that we are working on it. This new contracted service level guarantees that we call back the customer within 30 min and provide a remote solution or a scheduled on-site visit as soon as possible. These are exactly the 30 min that the customer formerly needed to call us initially.

3 Smart Services and New Business Models

The Heidelberg Cloud—the name of the IIoT solution that now connects over 13,000 presses with Heidelberg service—became a catalyst for the digital change. The introduction of eCall® in 2008 had an unexpected side effect: From this day on, we could configure machines to define which data the machine is sending us at what time. Originally defined to support field test scenarios, this capability is the key to agile, adaptive development of new smart and data-driven services. Since an IIoT platform has a very long lifecycle, we used this instrument to invent new services in months and not in years. Customer requirements for machine availability continued to grow, and big data-based services have been added to the Heidelberg portfolio since 2012.

By establishing the predictive monitoring service, we can forecast breakdowns and schedule appropriate maintenance work for maximum machine availability. The Heidelberg Cloud now collects data of the connected machines to detect anomalies in time series of sensors of a single machine, as well as deviations of one machine to the amount of all machines of a certain product line. This combined approach allows a high significance of the predicted cases and a replacement of unplanned downtimes to a planned service intervention—in the best case, paired with a regularly scheduled maintenance visit. The machine availability accumulates to a maximum if all the smart services are combined.

In addition to the services on which we focused to increase technical machine availability, Heidelberg developed a set of new services based on the existing Heidelberg Cloud connectivity.

To improve the productivity of print shops, we run our own consulting team consisting of industry experts around the globe. The Heidelberg Cloud disrupted this consulting service (cf. Fig. 3). The printing process performance data forms the basis for the team of experts who, together with customers, carry out overall equipment effectiveness (OEE) analyses and recommend and implement measures to increase productivity. More and more, a digitalized service department is thus changing from a repair workshop to becoming a partner and trusted advisor for the customer over the entire lifecycle of the press.

3.1 The Network Effect drives New Business Models

However, these smart services have another inherent characteristic: They create a network effect. The digital economy, thus, describes the phenomenon that the better the service has become for everyone, the more subscribers it has. Service providers

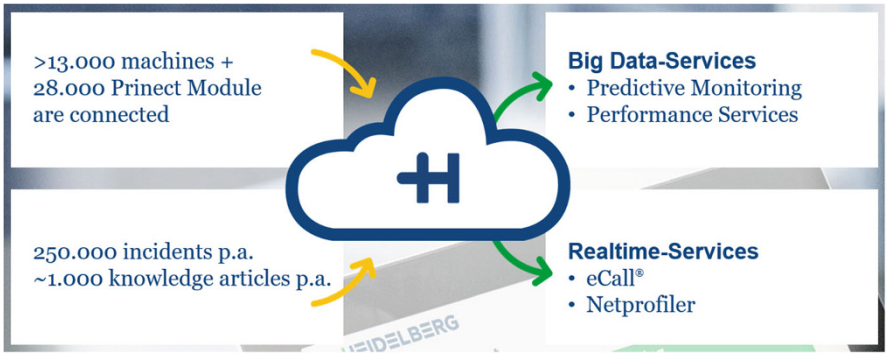

Fig. 3 Heidelberg Cloud—IIoT base for smart services. Own illustration

like Uber offer good examples of this: Many customers create a dense network of drivers, which leads to fast reaction times, attracting more customers. The same is true for Heidelberg's performance consulting services. For instance, the database now contains the technical OEE information of over 60 million print jobs worldwide, making it the largest database of its kind. This lays the foundation for the best advice, because the more comparable jobs are available, the better the potential for improvement can be identified.

While the early remote services, such as remote diagnosis and eCall, worked on a one-on-one level with limited scalability, smart services such as predictive monitoring and performance consulting profit from their network effect. We realized that it was a clever idea to build a foundational network with easy-to-entry services,but root for services built on the network effect. These services create a unique value-add for the customer, which is very hard to copy by followers in the competition. In this case, an early start ensures the pole position in the race and mostly ensures that the winner takes it all.

Until this point, we have developed new services under the model of service contracts. Today, more than 200 million Euros per year are generated from this business approach, which is profitable, but not a new business model in the sense of the word. Service contracts existed already for a long time before the smart service era and ensured the customers a certain service level at fixed calculated costs. Most of the service industry still operates this way.

In 2018, Heidelberg started an all-new business model—the subscription model for industrial print.

All traditional contracts were calculated cost-based with a markup. Reliable service cost with a high service level is a real asset for the customer. Nevertheless, if and how the customer receives benefit out of such a contract is mainly on his side. If we want to elevate the customer relationship to the next level, we must ensure that the delivered value of our contract is turned into a profitable business at the customer side. Linking customers' success and that of contractors leads to a new partnership, which is typical for new digital business models, such as subscription and pay-per-use.

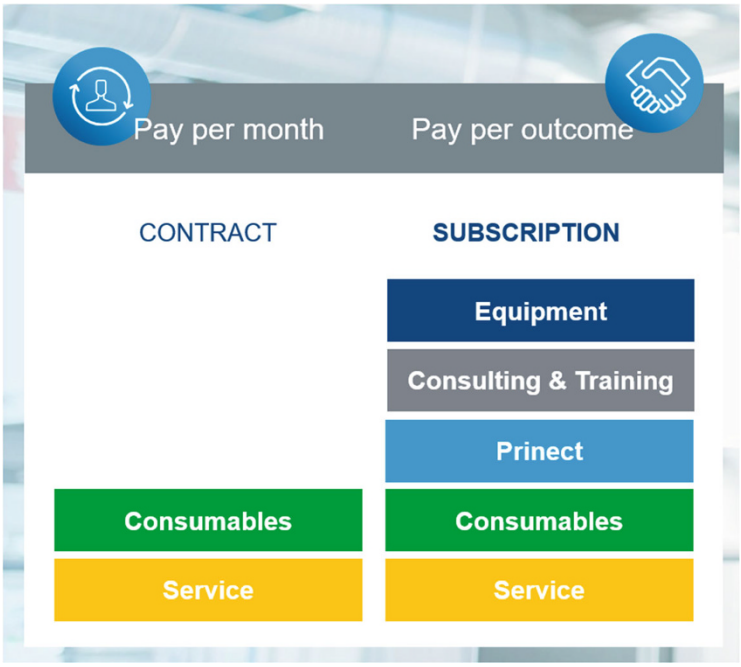

Fig. 4 Subscription business with a pay-per-use model. Own illustration

We achieved the transition toward an outcome-based remuneration by combining all our smart services into a new model. The customer no longer cares about the input factors of the production but focuses on the output performance. From the viewpoint of payment, it is a "pay-per-outcome" business model (see Fig. 4). Operationally, the new model requires a subscription to our performance consulting, which delivers the outperforming results. Driven by the network effect, the better the consulting service gets, the more customers subscribe to it. Previously, customers made separate purchasing decisions for machine investment, service, and consumables and then focused solely on performance and performance enhancement. The subscription approach combines these offers into a lifelong service package. Only the printed sheet is billed according to an individually negotiated agreement with the customer. The customer "subscribes" to the performance know-how and thus receives an economical optimum of his production. All services are included, such as predictive monitoring and eCall, to ensure maximum press availability. Consumables are provided via vendor-managed inventory with optimal reordering depending on the consumption.

Coming from a supplier-customer relationship, the new model demonstrates a true lifecycle partnership. This drives disruptive potential in the industry. Consider the "milky way" in Fig. 5 to illustrate our consulting approach.

Figure 5 provides a look into the Heidelberg Cloud from the viewpoint of a machine performance benchmarking based on the OEE. We collected the

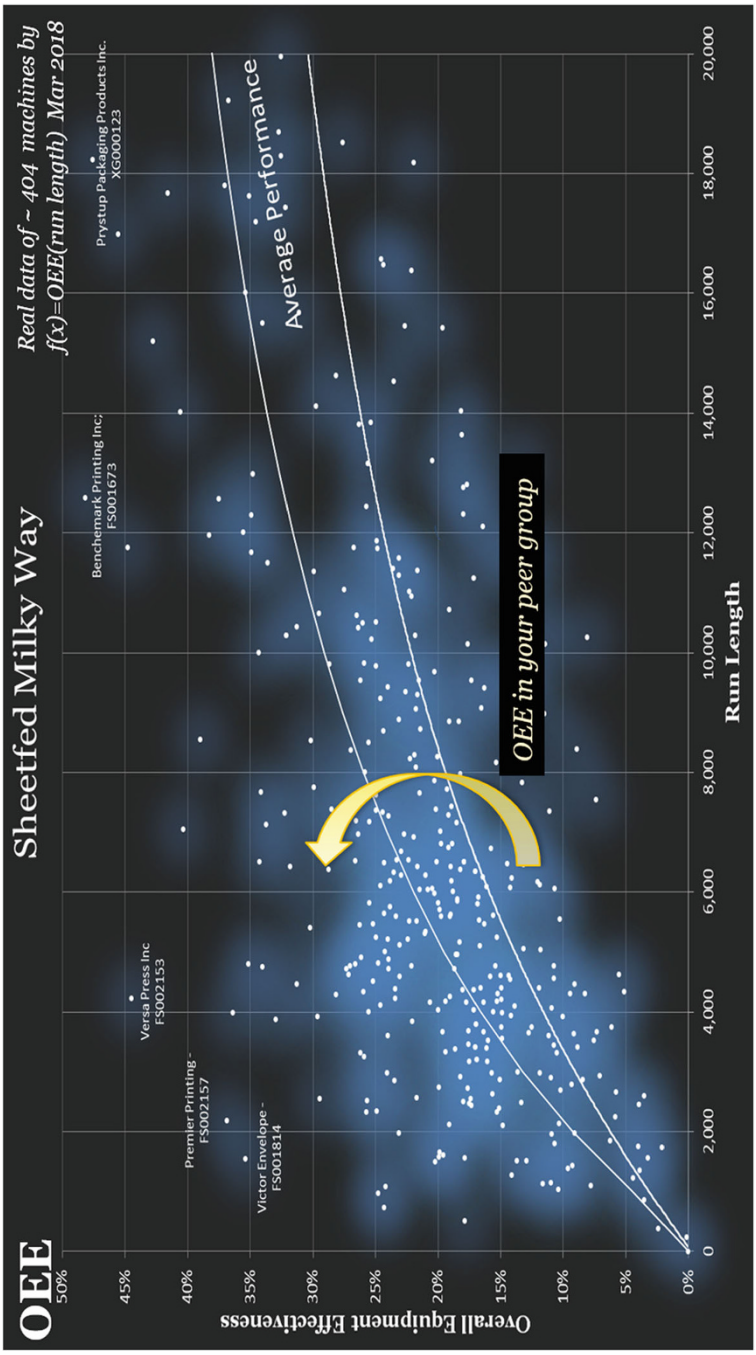

Fig. 5 Consulting database to prove performance and the potential. Own illustration

performance data from any make-ready process at the machine. Hence, we can compare the performance from one machine with a peer group of machines running similar job structures. This is needed because the same type of machine can run a very broad range of job characteristics, starting with thin paper applications for instruction leaflets to consumer boards used for the folding box of medicine. Defined as the "best-in-class" machine, performance is based on the Heidelberg Cloud data. Here, we have collected more than 60 million job data and can, therefore, find a fitting peer group for any customer. Notably, a customer produces on average 5000 jobs per year—feeding into the Heidelberg Cloud database and further fostering the network effect. The more customers subscribe to this consulting approach, the larger the database gets, in turn, improving the subscription results even faster.

To summarize the new business model, it is based on two pillars:

- First: The subscription to an outstanding performance consulting driving the network effect
- Second: An outcome-based billing, which aligns the success of the customer with our success as a solution provider

4 Scaling Smart Services

If we are 100% linked to experts executing the performance consulting, the subscription model can scale only to a certain extent. Application experts are hard to hire on the market, as they usually need a master's degree in print media technologies and 10+ years of experience. To solve this bottleneck, we integrated a new artificial intelligence solution in the Heidelberg Cloud. The "brain" in the cloud is named PAT—Performance Advisor Technology (cf. Fig. 6). PAT learns, starting from the set of expert rules, which pattern requires which performance improvement action. After applying this action, PAT observes the change of the measured KPIs and recognizes if and how good a measure improved the situation. After learning from the results, the loop starts again. PAT will not replace the highly skilled experts in the consulting job, but we expect that 60–70% of the recommendations can be executed by this artificial intelligence in the future.

Our new business model creates a very close relationship between customers and Heidelberg throughout the entire lifecycle of the product. To make it efficient and to meet the customer's 24/7 needs, a digital customer portal is essential—the Heidelberg Assistant (cf. Fig. 7). Here, the customer can do everything that used to be coordinated by telephone with just a few clicks: ordering service, an overview of delivery status and service calls, reordering consumables, managing his subscription stock, insight into the mileage of his machines, invoices, and much more.

We see a massive change at the executive level of our customers. A young generation of digital natives gets in leadership positions, and they decide about the business. A digital customer journey is mandatory for these young executives. Remember, just 15 years ago, we introduced remote diagnosis as a remote service and waited for a telephone call from the customer to start our service process. Today,

Fig. 6 "I am PAT"—Performance Advisor Technology—the brain in the Heidelberg Cloud. Own illustration

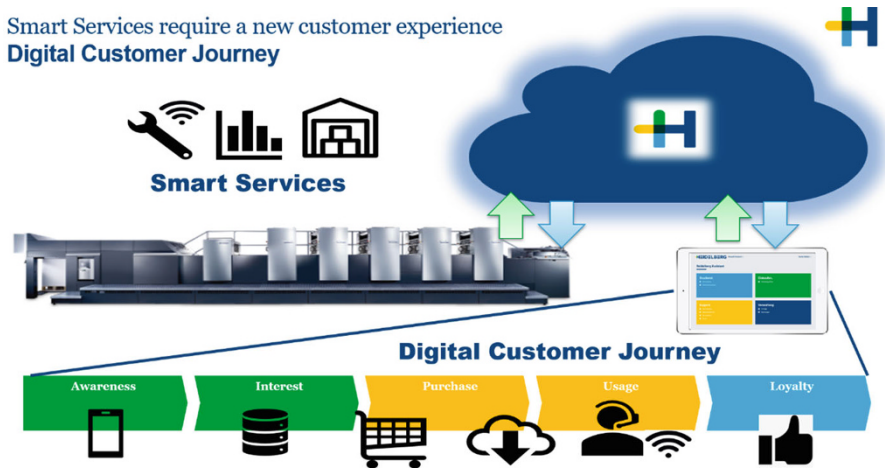

Fig. 7 Heidelberg Assistant—digital customer journey. Own illustration

a completely integrated customer portal provides real-time information about the service, supply, and performance status at any time to any role at the customer site 24/7. Considered as a wow feature, it is often expected by digital natives who grow up in the Internet age. Providing a state-of-the-art customer portal is key for a tight personal customer relationship and digital reachability. We have introduced the Heidelberg-ID—a personal account—that is the key to accessing all digital Heidelberg services. Providing this, we profile the users and can support their demand in the best way.

Fig. 8 The subscription business model as customer services in one app. Own illustration

Moreover, we experienced the creation of comprehensive, digital customer access that has a highly transformational effect on the service provider's own organization. Previous service systems were internal IT applications, performance data from the Heidelberg Cloud was only available to Heidelberg consultants, and the customer inquired about the delivery status by phone. Providing access to customers means the service provider must raise data and process quality to this digital level.

Let us come back to the performance consulting service as an element of the new business model "Subscription" to illustrate the impact of a digital customer journey (see Fig. 8).

Formerly, consulting had a very large on-site ratio. Visiting the customer to sell the consulting service started the journey. It was usually followed by a series of workshops to draw the initial picture, define the targets, and run the improvement session—in our case, every month. Action lists were typed into Excel and exchanged by email. Substituting the emails by a shared folder in a cloud repository is not digitalization in the sense of the word; it just replaces one media with another, but no process is changed. To change the game, you must rethink the consulting story from scratch. The Heidelberg Cloud, with the customer journey application Heidelberg Assistant, provides the platform.

Fig. 9 Heidelberg Assistant—customer performance benchmarking view. Own illustration

Figure 9 shows the Heidelberg Assistant with the performance benchmarking as the base for a joint consulting and performance improvement. Customers get a real-time view of their job structure, its "place in the race" benchmark, and the position within the entire industry. Finally, he gets an overview of the main performance KPIs, and he can focus on his improvement measures. If PAT is integrated, advice on how to improve a certain situation becomes automated too.

Our learning: Digitalization is NOT the continuation of offline processes and customer journeys. Digitalization requires a new design utilizing digital technologies to disrupt existing processes and business models, though it is difficult to adapt the organization to the new world.

4.1 Smart Services Are the New Normal

The COVID crisis is accelerating the digitalization of the whole industry. In 2020 we see the following immediate effects:

- Requests for smart services are increasing. The social distancing underlines the benefits of the existing remote tools and pushes acceptance on both sides—the customer and the service organization. It is the new normal to deliver technical services remotely, wherever possible.

- eCommerce order becomes the new standard channel for consumables and parts. While the overall consumption is not changing, the ratio of the digital channel increased significantly.
- A digital customer portal/app is used as a standard communication channel; this is no longer limited to digital natives, as elder employees accept the new normal and switch to the digital toolset too.
- New business models strengthen the customer relationship and make your customer and your own organization resilient in the crisis. They ensure recurring revenue, which works in the best case anti-cyclic but at least non-cyclic.

5 Executive Summary

Heidelberger Druckmaschinen started early in the digitalization of services and supply. The chapters above showed a journey of our development for more than a decade. Nevertheless, the key to success in an agile, challenging environment is stability. If you want to transform your enterprise toward a smart service organization, read these takeaways:

1. Build a lean corporate start-up team and work with agile methods. We did it and founded the Heidelberg Digital Unit as a corporate start-up. Don't limit your thoughts to improvements in the status quo. "Eat your own cake" is the message if your company is willing to disrupt the business. Merge two essential skills with an entrepreneurial mindset in this start-up: customer centricity and technology mastership.
2. Innovation is a customer-centric approach. A deep understanding of the market and customer needs is the foundation of any successful development of smart services and new business models. Design Thinking provides an ideal toolset to get customer insights. Beware of employees who know precisely what the customer needs but have never talked to one.
3. Master the technology challenge. Technology is the part of the digital story that can be bought. While that is true, keep the orchestration and the development of your core assets in your hand. An ambitious enterprise IT manager who lives the agile manifesto is a key resource for your start-up.
4. Finally, manage change resistance. Transformation of the business requires a transformation of your company. Measure the maturity of your current organization, your processes, and people for the digital change, and build a realistic roadmap. Ensure top executive support, but winning the heart, heads, and hands of the sales & service organization will make your transformation journey a sustainable success.

Adaptive Service: Digital Service Platform and the Service Crowd Community

Jost J. Bendel and Matthias Schiller

Schindler AG has been one of the world's leading producers of elevators, escalators, and moving walkways for nearly 150 years. Vertical personal transportation is, simply put, one of the crucial innovations that have made our modern cities possible—life without them is practically unimaginable. Yet as our signature products have become ubiquitous in over 140 countries, the maintenance of elevators and escalators has seen revolutionary changes in recent years.

The Internet of Things (IoT) and smart technologies are enabling new ways of monitoring and managing objects in the physical world, while massive streams of data are allowing for better decision-making—often mediated by machines (Turber, vom Brocke, Gassmann, & Fleisch, 2014). The analytical capacity of these connected and monitoring systems has evolved to the point that they can even make some maintenance decisions autonomously. They've changed maintenance from a rigid, time-based practice into a unit-specific approach based on well-informed decisions from unit information.

IoT-enabled systems are a fast-growing industry. McKinsey estimates that by 2025, IoT will have a potential total economic impact of as much as $11.1 trillion per year. In fact, IoT will be the biggest source of value of all disruptive technologies, ahead of mobile Internet, knowledge-work automation, cloud computing, and advanced robotics (Manyika et al., 2015). With this rapid pace of change, the role of human actors in the maintenance process of the future is more open, debatable, and undefined than ever before. Are these developments making the human factor involved in these analyses and in general maintenance more and more irrelevant? Will a time come in which we can dispense with the human factor altogether? So many of these questions can be boiled down to the following: How much knowledge resides in the machine, and how much in the humans who maintain it?

J. J. Bendel · M. Schiller (✉)
Schindler Management Ltd., Ebikon, Switzerland
e-mail: jost.bendel@schindler.com; matthias.schiller@schindler.com

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At Schindler, this question is more important than ever in guiding our drive to innovate maintenance. We're proposing a balanced approach to future digitalization: adaptive service. This novel approach is predicated on the idea that despite all the advances in machine learning, elevator and escalator service and maintenance, full digitalization is not able to cope with the complexity and change of the elevator and escalator service business by itself. Instead, it will be human-centric and collaborative to master complexity, create new opportunities, and continuously improve and innovate. It synthesizes the digital service platform with the service crowd community in a complementary manner.

This article will establish the concept of adaptive service based on the review of service maintenance methodologies, the path to full digitalization and main challenges, the distinctive strengths of the human factor, and how it can overcome the identified challenges. Finally, the concept of adaptive service will be detailed based on examples established at Schindler.

1 Service Maintenance Methodologies

With the emergence of sensor and IoT technologies, maintenance teams have gained the ability to monitor the health of individual components and make informed, data-based decisions about whether and by when they should be maintained, replaced, or repaired. The availability of this data has, in turn, given rise to different maintenance methodologies that take advantage of that data. Schindler refers to this network of sensor data for elevator and escalator installations as the Internet of Elevators and Escalators (IoEE), a specific version of the IoT.

The increasing ubiquity of sensor technology and connected devices has made it possible to move beyond planned maintenance, which was associated with significant material and personnel costs, general inefficiency, and low uptime. Under condition-based maintenance, the trigger for maintenance is no longer a predefined schedule, but the asset's actual condition monitored by sensors (Bellias, 2017).

In the elevator and escalator industry, the country or regionally specific norms are partly given strict boundary conditions, including the time and the tasks to be done by service technicians on-site. These norms are providing the framework in which the new maintenance planning can take place. Generally, we can observe that these boundary conditions are now often in discussion based on positive experiences in countries with fewer restrictions on planned maintenance. The IoEE-connected units make it possible to increase the total amount of checks with a shift toward more remote checks—partly 24/7—so assuring the same or higher safety levels and uptime.

This puts condition-based maintenance center stage. As Bellias (2017) explains, "with the automation of many industries and the explosion of computers and sensors, condition-based maintenance has become machine-led. Sensors built into equipment provide real-time readings to centralized systems, that help maintenance teams maintain equipment before problems occur. [...] Most companies have either

adopted or are working towards implementing rigorous condition-based maintenance programs to reduce cost while improving uptime."

As more assets become connected and computers gain the ability to use the generated data to not only display the current condition of an asset but rather to take an active role in decision-making, new forms of preventative maintenance are on the rise.

Following Bellias (2017), "predictive maintenance takes condition-based maintenance one step further. Once data is [provided by equipment in (near) real time], advanced analytics are used to identify asset reliability risks that could impact business operations." Simply put, where condition-based maintenance makes it possible for technicians to know if maintenance needs to be performed, predictive maintenance attempts to inform technicians of when maintenance will need to be performed.

Hence, by "applying machine learning and analytics to operational data generated by critical assets to gain a better understanding of asset performance, companies can act on these insights as part of a continuous improvement process. In addition, data beyond machines can be used for predictions, such as weather data, information from other systems beyond traditional enterprise asset management systems, and any other data sources that may be valuable" (Bellias, 2017). While predictive maintenance uses IoEE-enabled assets and the data that they provide to tell technicians when equipment is likely to fail, it does not definitively make the decision to conduct maintenance. It's often difficult to prove that a machine would have been broken when it was fixed already. Therefore, the business model that's often chosen with predictive maintenance is performance-based, so there's a single decision-maker for maintenance cost and performance. In this way, the decision-making associated with predictive maintenance is still based on human decisions.

Since prescriptive maintenance doesn't just analyze but also recommends suitable courses of action, it constitutes a paradigm shift that's making it possible to move from a prediction of when an event happens to a respective preparation of what has to be done. Prescriptive maintenance leverages advanced software to pattern identification points to explicitly diagnose root cause issues and then indicate precise and timely actions to promptly change the outcome. Analytic capacities are the foundation of prescriptive maintenance, and these "cognitive" maintenance systems are at the intersection of big data, analytics, machine learning, and artificial intelligence. This is currently considered to be the future of the industry by many companies.

Prescriptive maintenance requires a variety of asset management and maintenance systems to be well integrated into the overall system (Bellias, 2017). For instance, "a predictive maintenance solution might recommend that a piece of equipment [be repaired or replaced] based on an analysis of vibration and temperature readings, but a prescriptive system would [initiate] a work order to field technicians based on this information, including what has to be done and oversee the entire maintenance workflow" (Bellias, 2017). The role of a human would then be as a receiver of tasks that just has to strictly follow what's prescribed. Yet, the degree to which humans will participate in the maintenance decisions is still a matter of a great deal of research and debate.

2 The Journey to Full Digitalization

Full digitalization in maintenance can be understood as a maintenance system that automatically detects and actions anomalies using IoT-enabled connected devices—either performed by the installation itself or an AGV (automated guided vehicle) or a robot.

Technically speaking, the development of a fully digitalized elevator and escalator maintenance system is entirely possible. However, the questions of when it will be possible, how it can be developed, and the cost of doing so remain unanswered. With the current state of the industry, the development of such a system would surely take years and come at a great cost. Yet full digitalization is not just a question of task coverage, technical know-how, and ability; it must also be viewed from an economic perspective.

Based on the existing service methodologies, the focus was to identify when a failure happens and then go on-site shortly beforehand to keep the uptime of the equipment as high as possible. Prescriptive methodology further optimized this approach. These methodologies have been built in industries where access to the equipment and/or downtime of the equipment is most important. In the elevator and escalator industry, this is also true for the so-called callbacks or when a unit is stopped. Yet the time and cost needed to access a unit in a safe manner are relatively high. Performing a task early when on-site makes more economical sense than waiting for the latest possible date. Therefore, the network optimization of all resources has an essential role in service business optimization and needs to be considered in task coverage.

Costs still limit the full automation of elevator and escalator maintenance. These costs include development and implementation and the necessary physical space and infrastructure in future and pre-existing units, as well as the decreasing of overall costs of employing humans to do the same task. As such, the execution of on-site maintenance is likely to remain human-based until there's more incentive to resolve the cost-prohibitive status of a fully automated maintenance unit. The extent to which automated or robotic maintenance systems could aid or replace the humans in the elevator shaft or under the escalator is still a subject of discussion and research in the industry, as are its inherent advantages.

The complexity of using mixed systems and various models, which is not uncommon in many buildings today, should not be underestimated when considering the implementation of a fully digitalized system. With so many manufacturers around the world having manufactured a plethora of different models over decades or even a century, elevator and escalator systems are hardly consistent. Often this kind of complexity in the field becomes obvious when the service technician arrives on-site and needs to figure out what to do and how. Often the most appropriate maintenance measures are based on the experience and knowledge that has been gained over years of work and handed down to the next generation of service technicians (e.g., when fixing topics jointly on-site). A fully digital system with the same knowledge and ability to cope requires having a comprehensive and high-quality database. Collecting all this data and ensuring its quality is a big challenge.

This adds immense complexity to the digitalization process and creates a significant obstacle for the creation of fully digitalized systems. While AI and ML can generate data sets for these unique mixed installations and use them correctly over time, those data sets will only be relevant for the system itself or for an identical mixed system with the same models and physical parameters. That means that fully automating mixed systems would largely have to be done on a case-by-case basis. This drastically increases the effort to fully digitalize while at the same time decreasing the incentive to do so.

Elevators and escalators are means of human transport and are therefore affected by their behavior. Blocking doors, for example, instead of using the buttons, have a negative effect on the status of doors, potentially leading to a breakdown. Prediction is difficult for a specific unit and can be done in more of a general way, like for big events and the respective units in this area. With the current COVID-19 challenge, passenger behavior and usage patterns have changed significantly, also driven by new ways of interaction with the elevator via mobile phone apps or touchless sensors. Predictions for units have their limits due to a lack of historical data.

As more and more devices are connected to the Internet of Things, particularly close attention must be paid to security and privacy. On a seemingly monthly basis, we're treated to stories of spectacular hacks and security breaches at a wide range of companies with all kinds of data and solutions. Usually, it's the loss of personal or financial data or politically sensitive materials. But connectivity and data associated with mobility solutions add a new dimension with regard to security. The consequences for the industry for security breaches in fully digitalized, AI-driven escalators and elevators could be severe. Going forward, manufacturers and service providers will need to invest heavily in cybersecurity in order to initiate dedicated programs and organizational units that ensure total data security. All communication is encrypted using the highest security standards, and just the minimum required data is collected (Gupta & Schneider, 2018). Data privacy is of the strongest concern for Schindler and is an area in which the company is seeking collaboration with data and security experts in academic institutions.

3 The Human Factor: Experience and Creativity

The advances in prescriptive maintenance can only be applied reliably with enough relevant data. Without it, the systems will fail to truly understand all the relevant patterns. That's because machines will only make decisions based on the data they have. They lack the experience and creativity to solve unforeseen or unique maintenance issues because they can only derive this data from previous experiences. These are the gaps that humans can close in tandem with the digital platform.

Schindler embraces the need for human involvement while using technology to optimize their role to the greatest possible extent. Knowledge is available from different sources, such as the unit documentation, but also from the minds of human service technicians. The internal saying goes: "When Schindler knows

what Schindler knows." The limitation here is often language-driven as the technical proficiency is typically in the local language.

The role of human creativity is not just important for individual maintenance tasks but also crucial for analyzing and improving the overall maintenance process. While smart technologies employ AI and ML to predict and prescribe the replacement of components, they can't interpret data to suggest improvements to the overall system beyond those singular measures. Only human technicians with access to the experience and knowledge of other, more versed human technicians can examine the situation and make appropriate and creative decisions to further streamline the entire process. That's why our company is actively training data scientists for special functions in the Technical Operations Center. Only when the technicians master analysis and problem-solving can a genuinely productive network be created.

Schindler believes that streamlining the availability and accessibility of human knowledge and experience will lead to the next level in maintenance. Innovation is a crucial factor for success for staying competitive while optimizing and rethinking processes. It also offers new services to our customers. These new ideas are based on creative thinking done by humans. As an example, within 3 months, a total of eight new products have been developed to fight the COVID-19 pandemic. It includes the award-winning UV light for escalators that ensures clean handrails. To achieve this, Schindler leveraged the global team in all countries.

The predictive and prescriptive maintenance approaches and technologies that have been developed over the past decade remain a tool of the humans in the process. Keeping in mind the obstacles to the full digitalization of elevators and escalators described earlier, Schindler argues that we should accept the current human-led approach to maintenance and develop and plan solutions based on it for the foreseeable future.

4 The Service Crowd Platform: Adaptive Service

Developed by Schindler, adaptive service is a unique way of performing elevator and escalator maintenance that successfully fuses elements of predictive and prescriptive maintenance integrated with a dynamic planner complementing the service platform while emphasizing the human factor in the process by high usability and collaboration that enables the crowd to collaborate. Together, adaptive service is a flexible and continuously learning service crowd platform. As such, it combines the latest AI-driven digital technologies and processes with human expertise to maintain a unit according to its one-of-a-kind condition. It has the personal and technical ability to immediately rearrange processes, methodologies, and capabilities to maintain equipment according to its current requirements. In other words, adaptive service does not require elevator and escalator units to be so similar and then improves the capacity to work with mixed units.

Starting from the Schindler Ahead platform, the main areas to work toward this vision are:

1. Complement the service platform by feeding the gained insights and recommendations with dynamic resource planning, including material and people to bring insights to concrete actions for the field integrated into daily schedules.
2. Standardize the user interfaces (HMI) of the service platform and the people in the field—internal and external—to limit user training need of the tool(s), reaching high user acceptance.
3. Globally connect the crowd—all users of the service platform—by respective multilingual collaboration tools and knowledge documentation.

Adaptive service makes use of the powerful IoT-platform Schindler Ahead to analyze cloud-based data in real time, so that potential issues can be anticipated and resolved before they occur, moving the methodology beyond predictive maintenance. It provides operators and building managers with real-time status reports and tailored apps that enable them to check on operational performance and commercial data to better manage their equipment portfolio.

In order to create a maintenance methodology that best supports the human technicians who perform the maintenance, adaptive service works as a closed-loop system. In a reciprocal cycle, information is collected, analyzed, and translated into the precise instructions needed for the human technicians to take the appropriate corrective steps. Incoming messages are automatically evaluated within seconds and assigned to service technicians for analysis and decision-making.

Adaptive service offers asset managers and technicians the benefits of both worlds: human expertise and advanced technology. Adaptive service is always provided on the basis that the two work in symbiosis; humans are supported by the technology to complete maintenance tasks and, in turn, contribute their knowledge and learned experience to managing the asset and the industry as a whole, allowing for the development of better units and the better maintenance thereof (Fig. 1).

In the closed-loop adaptive service maintenance approach, elevators and escalators relate to the Internet of Elevators and Escalators (IoEE) using Schindler-developed Ahead Connectivity. This enables any type of unit to be monitored in status and performance by the Remote Monitoring Platform, which transforms data into meaningful insights and information for service technicians, technical operators, and customers.

Adaptive service is specifically designed and implemented to support the human element in the maintenance process. Here's a short overview of some of the most important ones:

Ahead Remote Monitoring Platform: Analytic platform turning data into actionable insights, which improves response time, predictions, and information overviews.

Technical Operations Center: Field support by experts using the Remote Monitoring Platform and Analytics. It enables improved uptime and improved first-time fix rate.

Field Tool Suite: Includes tools such as FieldLink, FieldBoard, FieldSupport tools and modern digital toolset for Schindler Service Technician and Service Leader

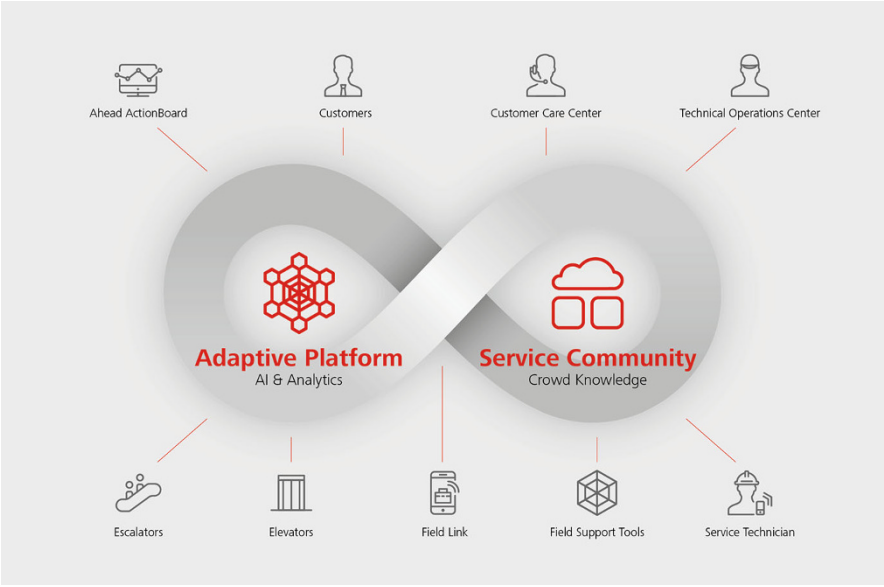

Fig. 1 Digital closed-loop adaptive maintenance process. Own illustration

offering daily support in accomplishing tasks and customer service. They are used as a single standardized user interface for service technicians.

Dynamic Planner: A digital work planning application that organizes all jobs based on prioritization and optimized travel for service technicians and subcontractors into daily schedules accessible on their smartphone's FieldLink.

Crowd Knowledge: Multilingual database and ticket system that make it possible to gather insights on technical aspects from around the world with automated translations and expert advice. Faster resolution through combined expertise with the globally combined expertise resolutions is found much faster. After a solution is found, it's automatically made available in all local languages worldwide.

Ahead ActionBoard: Digital information and portfolio management tool (web- and app-based) for customers with status and service information. Provides the correct information to work with and a single point of contact.

At its core, the focus of adaptive service is to enable the human workforce and to adapt working principles that foster a reciprocal and mutually beneficial relationship between AI/ML-driven maintenance technology and the people who conduct the maintenance. Schindler has already made many important strides in accomplishing these goals. Yet as the industry progresses and AI/ML potential expands, Schindler continues to search for new and better ways of integrating human technicians into the data-driven maintenance process.

5 Adaptive Service in Practice

Though a variety of solutions and tools can be implemented using Schindler's adaptive service methodology for the maintenance of elevators, escalators, and moving walkways, the overall goal is always to increase uptime of the elevator, escalators, and moving walkways in a safe way. Proper monitoring and maintenance are required to achieve this goal. Ideally, each unit is maintained based on its condition and with a unique maintenance plan. The industry is moving to this one-on-one relationship, but maybe achieving this state is neither commercially relevant (yet) nor as impactful as it is said. Instead of searching for the one-of-a-kind maintenance process, Schindler is moving forward to become more flexible and knowledgeable as a service crowd platform to act upon findings with its workforce, tools, and routines in maintenance.

The examples below demonstrate the closed-loop approach of adaptive services as it is already tested and implemented in Schindler:

5.1 Connectivity

The process always starts with the collection and analysis of installation and monitoring data. At present, Schindler has developed a range of products that collect data directly at the installation and pass it on to a solution that aggregates it into a clear dashboard. One such solution is the Schindler Ahead Cube, which was specifically designed to collect, analyze, relay, and act on the Internet of Things data at the edge of the network. These edge capabilities make it possible to optimize the use of bandwidth and concentrate data into the necessary tier at the necessary time—resulting in a general reduction to overall solution latency.

Gathering the data, respectively, connecting the elevator, escalators, or moving walkway can be done in two ways:

- Directly via the controller of the installation, which is called "embedded telemonitoring" (ETM). Before data is pre-analyzed in the Cube, the controller gathers and provides error codes, statuses, and other messages. A typical controller can already submit thousands of different messages that need to be "understood," combined, and analyzed and a symptom created. The smarter the controller and algorithms become, the better the diagnostic will help the human prevent or solve issues.
- Indirect via a range of sensors, which we call sensor kits that "feel what the installation (and passenger) feel." Not all or older controllers simply do not provide that much data nor insightful states. Sensors help monitor the status and condition and help watch statistics to base decisions and actions upon (Fig. 2).

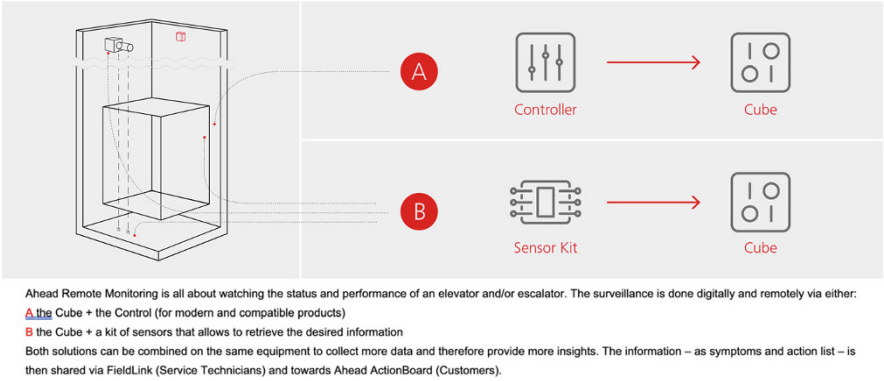

Fig. 2 Elevator connectivity. Own illustration

5.2 Insight

The analysis and prioritization of that data, in part by the system itself, and the resulting recommendations and prescribed courses of action form the core of the adaptive platform. As such, once the data is collected from the installation by the Schindler Ahead Cube, it's processed and classified based on a range of "symptoms." In fact, over 6000 different algorithms/rules are used for packaging the data into these symptoms, which are then categorized into classes. At this point, a technician can be activated and dispatched to the respective location. Dispatched service technicians receive clear information instructions through their FieldLink app, which has a very high rate of acceptance among internal technicians (Fig. 3).

The Technical Operations Centers are the new organizations combining connectivity, technical, and data science experts reviewing and closing the loop of the system. Additionally, they are performing remote maintenance tasks where the system cannot do it automatically or fast reaction time is required. The standardization of these Technical Operations Centers is ensured with a global training and certification.

The relevance for adaptive service is that the Technical Operations Centers act as a vital intersection between machine-driven analytics and the aggregation of human-based experience and expertise.

The implementation of an elevator fragility indicator into the mix is an example of what takes this approach from being condition-based maintenance to being adaptive service. By analyzing equipment-specific configuration and usage, a machine learning model extracts the maintenance demand individually and then identifies the main drivers for fragility within the model. This way, a service leader can assign the appropriate maintenance level based on data—even in advance of any elevator monitoring data and even for new units coming to the portfolio leveraging the existing insights.

Based on this analysis, installations are classified, and a service-level recommendation is made. That analysis report shows the recommended service level, the

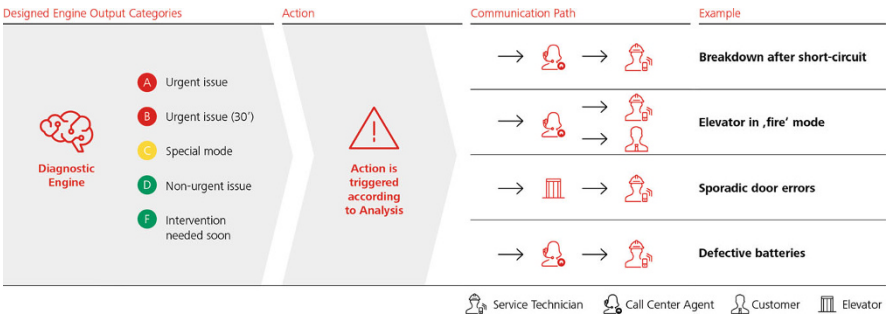

Fig. 3 Diagnostic engine. Own illustration

classified fragility level of a unit, as well as the main drivers that trigger a moderate, high, or critical fragility level. Based on this evaluation, machine-driven analytics have prioritized the installations based on the amount of attention required from their human administrators, taking a degree of the decision-making from them and at the same time concentrating their expertise and ability where needed. This is a classic example of an adaptive approach to maintenance that uses the best of both machine and human participations.

5.3 Dynamic Planner

To make the insights actionable, they must be put into meaningful information and sequence for the service technicians. In all of them, Schindler is applying the same quality and safety standards independent of the original manufacturer or age of the installation. Nevertheless, every task has different criteria to reflect this:

- Time slots (i.e., access to an elevator in a shopping mall is best before the opening to avoid friction)
- Qualification or material required
- Amount of people (typically one man or two men)
- Urgency (maintenance tasks vs. entrapment)
- Others like contractual agreements

To handle this complexity for a single service technician, a dynamic scheduling system automatically calculates and proposes the ideal sequence of the tasks. It gives different points based on the criteria, prioritizes them, and combines them in a travel time-optimized sequence. As a result, the service technicians get the respective task list on their FieldLink.

The list is still flexible enough so unforeseen events can be reported and taken into consideration in real time. So, for example, a callback takes place, and the remaining jobs of the day are pre-planned based on the new location the service technician is at.

Unnecessary travel (e.g., due to missing material) and high coordination efforts, especially for two-man jobs, are taken up by this "virtual assistant." Additionally, tasks that need to be done in the future are already partially done when being on-site. Even though this counteracts the predictive maintenance logic of going as late as possible to the units to fix it, the network optimization has a superior optimization of the resources with its more holistic view and therefore will achieve a higher uptime for the customer as one additional visit can be avoided.

5.4 Human-Machine Interaction

The complexity of the existing installations with their different manufacturers and age of installations can be easily exhausting for service technicians, especially when it comes to non-standard situations. Particularly, as controllers of elevators and escalators have information based on codes and numbers instead of plain text, the knowledge and correct interpretation is important. At every visit, the elevator's error log will be looked at; this is a common and broad challenge in the elevator and escalator industry.

To ensure the right information at hand, Schindler has invested in a co-creation approach with the field to define standard user interfaces to controllers. In addition to FieldLink, where the insights are shared, the FieldSupport tool for Schindler Elevator Control Interfaces harmonizes human-machine interaction for service technicians. The service technician is fully enabled with available information to evaluate the situation and make a decision for the next step.

5.5 Leveraging the Crowd Globally

Schindler maintains non-Schindler and Schindler equipment, the oldest still in operation, dating back to 1911. One can imagine the vast range of technologies that are still to be maintained, not to mention the unique solutions of a global range of manufacturers. Crowd knowledge makes it possible to educate all field force workers on all those "foreign" and "old" technologies. That way, we ensure that the 20-year-old job starter has as much access to the same knowledge, instructions, and training as a senior expert with 40 years' experience.

The crowd knowledge platform provides technical Q&A and a ticket system in a multilingual environment. With this, a type of "Wikipedia" is built based on cases managed in the ticket system. The tickets give the field support an integrated flow of questions and answers from the field up to the research and development centers. Only when the solution has been rated as successful by the service technician will it be made available in the global library. Everyone is then able to search and access the solution and rate it. These ratings help review and ensure that the quality of the insights creates an ever-growing and ever-improving database of knowledge.

These examples of the integrated service crowd platform illustrate the ways in which adaptive service creates a new level of symbiosis between date-driven

machine-based decisions and recommendations and the ability and expertise of their human counterparts. At Schindler, we assert that this is the future of maintenance and strive to develop new practical solutions that make it a reality.

6 Conclusion

The ultimate goals of Schindler Service are improved uptime, better quality, and continuous innovation. We know that innovation is not achieved through rigid development practices, and we want to encourage and enable more experimentation and open-ended research. According to Thiel and Masters (2014), "Today's 'best practices' lead to dead ends; the best paths are new and untried." In this spirit, we're looking to make innovative progress and investigate completely new possibilities in elevator and escalator maintenance. Historically, successful investors pursue a large number of sometimes competing innovation ideas either alone or with partners and push initially unsuccessful ideas back onto the market following recombination and iteration (Westerman, Bonnet, & McAfee, 2014). To take full advantage of new digital technologies, Schindler is looking to diversify its global IoEE program and adaptive service solution with multiple avenues of research.

Adaptive service is a unique way of performing elevator and escalator maintenance. It combines the latest digital technologies and processes with human expertise to maintain a unit according to its one-of-a-kind condition. The promise of IoT as the basis for digital transformation lies in "supercharging business to better serve customers and stakeholders. But to fully realize IoT's potential, companies need to approach it as a multifaceted journey, making changes to their business models and strategies—or risk ending their trip before it really begins" (Kranz, 2017). Schindler IoEE successfully proves that simply connecting a "thing" to the Internet isn't enough. We must be able to ensure that the data generated by that thing can be leveraged to enable new business benefits—and that data will ultimately be the tool of a human technician.

Yet, we want to encourage the industry and innovators at large to spend equal time and effort to find new ways to help technology support the roles of human experts. The world is at present enamored with the idea of "human-less technologies," machines, and solutions that fulfill our needs and wishes without our direct involvement in their operation. Let us not lose sight of the human factor—our own role—in the day-to-day maintenance and operation of our mobility solutions. Sharing our knowledge and finding more efficient ways of doing so have the greatest potential to revolutionize the industry. We remain convinced that building and maintaining the human networks of expertise and experience have the greatest potential to bring positive change to maintenance methodologies in the future, and we continue to explore new ways of doing that every day.

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Enabling the Dealer Network to Deliver Smart Services

Giulio Tosato

1 Company Introduction

John Deere was founded in 1837 and has grown into one of the world's leading equipment manufacturing companies. With more than 73,000 employees working in 125 facilities around the world, the company made a revenue of 39.26 billion dollars and a net income of 3.25 billion dollars in 2019, the second highest in the company's history. The company's financial performance allowed it to make further investments in advanced products, technologies, services, and other growth-oriented projects. For year 2019, John Deere devoted 2.9 billion dollars to research and development and capital expenditures.

John Deere is the world's leading producer of agricultural equipment, offering full lines of tractors; combine, cotton, and sugarcane harvesters; tillage, seeding, nutrient management, and soil preparation machinery; sprayers; hay and forage equipment; and integrated agricultural management solutions. The primary geographical markets for John Deere are the United States and Canada, Europe, Brazil, Russia, India, and China. The global business operations include not only agricultural products but also construction and forestry equipment, lawn and garden, as well as additional supporting businesses such as Intelligent Solutions Group, Financial Services, Power Systems, Parts Services, and Electronic Solutions. John Deere is operating in four geographic regions that were defined by the company based on customer needs and market similarities.

John Deere dealers are fundamental to serve customers globally. They build relationships, sell products, and keep customers up and running by providing parts, service, and advice. Dealers represent the most significant and enduring way to differentiate John Deere in the market. Thus, it is of strategic importance to develop a distribution system that enables John Deere to gain and maintain

G. Tosato (✉)
John Deere Walldorf GmbH & Co. KG, Walldorf, Germany
e-mail: TosatoGiulio@JohnDeere.com

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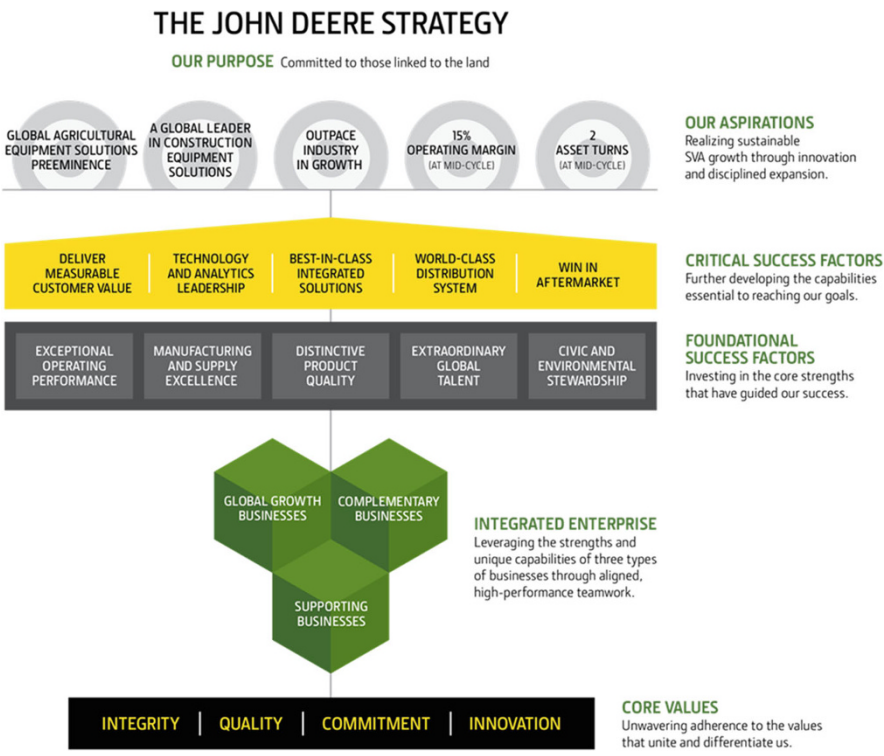

Fig. 1 The John Deere Strategy. Own illustration

preeminence in all markets in which John Deere competes around the world. In agriculture, some dealers will have to serve large, technologically sophisticated customers with tens of thousands of hectares and acres of land under cultivation, as in Brazil and, increasingly, Russia. Other dealers will have to serve many small-hold farmers, each with a few hectares of land and little access to mechanical or biological technology, as in China, India, and sub-Saharan Africa. Similarly, construction equipment dealers will work with customers ranging from large contractors to smaller owner-operators.

The John Deere Strategy grounds on four core values: integrity, quality, commitment, and innovation (cf. Fig. 1). Throughout the company's history, these values have proved crucial to expanding its global presence and providing customers with exceptional productivity and reliable performance for equipment and services.

In support of the strategic plan (cf. Fig. 1), John Deere is placing a particular emphasis on five critical success factors:

- *Deliver measurable customer value:* Customers' demands continue to evolve, and they are relying on advanced technology to run complex operations. John

Deere is in an ideal position to help customers solve problems and add value to their operations.

- *Technology and analytics leadership:* Rapid advances in IoT and analytics are reshaping the equipment industries and requiring John Deere to systematically build new business capabilities to create industry-leading innovation enabled by technology leadership and data analytics.
- *Best-in-class integrated solutions:* While product leadership is critical to the success of an integrated solution, customers will increasingly choose the equipment provided by a company that can deliver the best overall solution by seamlessly connecting machines, people, technology, and insights.
- *World-class distribution system:* The John Deere dealer network must continue to evolve to serve the rising expectations of a diverse customer base by delivering solutions, precision technology, and distinctive support.
- *Win in the aftermarket:* The aftermarket is a critical part of the business both for John Deere and the dealer network in terms of delivering a distinctive customer experience throughout the product lifecycle.

2 After-Sales Service Innovation

Innovation in the after-sales service is recognized by John Deere as a strategic area linked to all five critical success factors previously described. Thanks to service innovation, it is possible to define technological aftermarket solutions that are delivered by a progressive dealer network to satisfy customer needs. Concerning machine field operations, customers want equipment that does the job when it needs to be done, relying on a high level of machine uptime. However, in the field, the unexpected can happen, and when it does, customers need dealer support for quick problem-solving. John Deere Connected Support™ is a customer-focused enterprise initiative that allows John Deere customers to experience new levels of machine uptime and reduced operative cost through the combination of a smart connected product, remote service tools, and proactive dealer support (see Fig. 2). John Deere Connected Support™ enables the dealer network to deliver a new type of smart service—so-called remote machine monitoring—in terms of being able, with customers' consent, to remotely monitor machine condition and preemptively advise the customer on maintenance and repair needs, minimizing field operations disruptions, and also avoiding serious repair costs.

Fig. 2 Elements constituting John Deere Connected Support™. Own illustration

In the context of John Deere Connected Support™, the role of the dealer network is fundamental as a provider of the smart service, ensuring its value to the customer. This is only successful when the necessary organizational capabilities are available at the dealership, which is a precondition that directly impacts the after-sales service organization of the dealers. On the one hand, John Deere Connected Support™ is considered by John Deere as a trigger for organizational innovation and as a source of service differentiation. On the other hand, its implementation requires certain development activities for the dealer service organization in charge and even can challenge some established practices.

3 Dealer Implementation of John Deere Connected Support™

The implementation of John Deere Connected Support™ across John Deere dealers is directly linked to developing the necessary organizational capabilities. The dealer's after-sales service organization needs to ensure dedicated functions and activities for the successful delivery of the remote machine monitoring smart service. Recognizing the importance of developing the necessary dealership capabilities, an exploratory approach was chosen by the customer and product support team of John Deere to identify what factors influence the implementation of John Deere Connected Support™ in the dealer's after-sales service organization for the successful delivery of the smart service.

The exploratory approach was based on a pilot program defined by the collaboration with selected European John Deere dealers among representative markets. For each pilot dealer, the required remote service tools (Fig. 2) were enabled, including dedicated training and support. This allowed the pilot dealers to work with the remote service tools and deliver the remote machine monitoring smart service. The exploratory approach was conducted using a two-step approach. First, an evaluation framework was defined internally by identifying and categorizing the factors that are typically considered for dealer development activities executed by John Deere in the after-sales service. Second, a workshop with the pilot dealers was organized to further analyze and consolidate the factors identified in the first step and to relate them to the practical context of the dealer's after-sales service organization.

Based on the evaluation framework analysis and the workshop, we identified six success factors relevant to the implementation of John Deere Connected Support™ in the dealer's after-sales service organization. Each success factor is presented in the following six subchapters.

3.1 Management Commitment

The evaluation framework of John Deere presumes a visible commitment from dealership managers and company owners to trigger innovation in the service organization. It also requires an entrepreneurial spirit when it comes to capturing

new aftermarket opportunities. Furthermore, managers should not only act as a reference for the John Deere Connected Support™ initiative but also personally involve themselves in the implementation process to take care of possible challenges and to foster a proactive service mindset within the organization. This can be accomplished through a participative approach involving the dealership employees in the definition of the implementation at its early stages.

In the workshop, we identified three main attributes for management commitment: strategic, customer, and organizational. Regarding the strategic attribute, the pilot dealers highlighted the importance of the management being able to define an execution plan with clear targets in the short and long term. In particular, financial support for the implementation activities may be required. Concerning the customer attribute, dealer management has to be committed to understand and embrace the value of John Deere Connected Support™. In this way, it is possible to convey the customer value proposition of the smart service to support machine field operations, especially with key customers. The last attribute (i.e., the management commitment in relation to the organization) explains that managers and company owners shall be capable of clarifying the benefits for the dealership of implementing John Deere Connected Support™, ensure clear communication about the implementation approach, allow the creation of a dedicated team, and promote a stronger collaboration across all dealership departments. In this regard, a clear need has emerged for the dealer management in coping with the necessary organizational changes in the service team to ensure its engagement. It can be demanding to fully involve the service personnel in the early stages because their focus is on the execution of daily service activities (e.g., equipment repair and maintenance), instead of implementing an innovative service approach. This situation can be less impactful for dealerships that are in the process of setting up a new business strategy anyway as this may represent the ideal occasion for the management of all departments (service, sales, and spare parts) to review their operations and become committed to implementing John Deere Connected Support™.

3.2 Organizational Structure

John Deere recognizes the implementation of John Deere Connected Support™ as a trigger for dealers to further develop their organizational structure, meaning the way by which the service delivery activities (service jobs and people actions) are divided, executed, and coordinated. Pilot dealers identified the importance of coordinating the workforce involved in the provision of the remote machine monitoring smart service. One approach proposed by John Deere is the creation of a centralized machine monitoring center at the dealership with the following tasks:

- Monitor the machine condition remotely and in real time.
- Inform the customer in case of any identified technical issue.
- Organize the necessary resources and materials to execute repair activities.

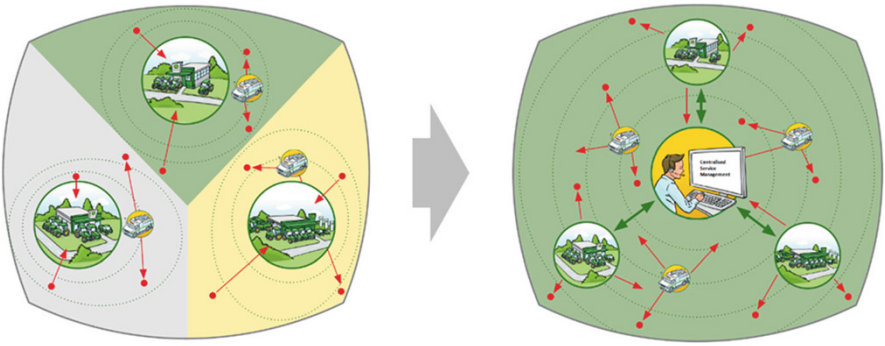

Fig. 3 John Deere Integrated Customer Support Network. Own illustration

- Evaluate other support activities to minimize the impact on customer's operations.

This approach aligns with the dealer organization guideline "Integrated Customer Support Network," provided by John Deere (see Fig. 3 below). It describes the idea of moving from dealer service locations working independently to a coordinated and integrated dealer service network. The decision on the organizational structure—either centralized or decentralized—can depend on the dealership configuration, which relates to the size and existing settings. Large organizations may already have the capabilities to identify and deploy a centralized organizational structure. This entails an integrative approach to ensure co-existence with present organizational practices. Overall, a gradual transition to the new organizational structure was recommended by the pilot dealers, ensuring close collaboration with the concerned teams.

3.3 Operational Structure

The key condition identified both in the evaluation framework and in the workshop relates to the definition of an operating process. Today, the traditional after-sales service is already process-based, and technology-based services like smart services can lead to superior value creation only when the operating processes are designed accordingly. Based on the evaluation framework findings, the characteristics of the dealer process for smart services are:

- Aimed at fulfilling customers' service expectations
- Owned and coordinated from a centralized service team
- Supported by a tight collaboration among dealership departments
- Enabled by a proactive service approach to provide a rapid and effective response
- Characterized by a new level of interactions with the customer

The last two characteristics—proactive service approach and new customer interactions—represent the innovative core elements of the operating process for John Deere Connected Support™. Essentially, by leveraging the remote service tools for machine condition monitoring, the dealer is informed when a machine is facing a technical issue, and he can proactively inform the customer about the necessary service activities to keep the machine operational. In a traditional after-sales service, the customer informs the dealer about a machine problem, who then organizes the required actions following a reactive approach.

According to the pilot dealers' feedback, the definition of a specific operating process is positively impacting the working efficiency of the service organization. Improvements are especially seen in organizing the assistance of customers' machines. The delivery of remote machine monitoring smart service allows the dealer to have detailed information about the machines' technical issues, including the most appropriate resolution, and to schedule the service job for service technicians accordingly. This results in improved working conditions for service technicians, as well as increased labor productivity enabling the dealer to satisfy customer service needs, especially during high-demand periods like the harvesting season.

The workshop discussions identified the importance of ensuring clear communication not only with the workforce involved but also with the customer while executing the operating process. The type of information ranges from the description of the operating process to a tracking system for the service execution. The latter helps keep customers informed on the smart service delivery status, a condition that is especially important for the first delivery experience.

3.4 People

Pilot dealers recognized people as the most relevant factor, delineating its importance for the dealer implementation of John Deere Connected Support™. Both the evaluation framework and the workshop discussions identified three attributes: required skill set, recruitment of desired personnel, and provision of training.

Regarding the required skill set of the workforce involved in the smart service delivery, all pilot dealers envisaged the need for new talents, but did not specify the type of skills and especially the desired behavior supported by every skill, mainly due to the innovative character of John Deere Connected Support™. The evaluation framework, hence, provides more precise indications of the desired professional behavior. It is an open attitude of the employees to adapt to a different job environment characterized by new technologies and work situations that can change quickly. Going beyond technical skills and working conditions, a key competency is the ability to understand the customer's entire business operations to identify service needs and fulfill them proactively and successfully with a dedicated solution. This results in the ability to strengthen the customer relationship.

The innovation brought by John Deere Connected Support™ in evolving the service people skill set is reflected by recruiting the necessary workforce. The

workshop discussions highlighted the potential need for new resources, and pilot dealers mentioned that a manager and a specialist for John Deere Connected Support™ are the required people. In some scenarios, specialized personnel may represent higher salary costs compared to the traditional service technicians, and in other situations, there is no immediate need to recruit new employees as a large team is already employed in the dealer service department, and resources can be reallocated. It might also be difficult to find qualified personnel in the short term, highlighting the importance of defining a new job description for the required staff. John Deere indicates that a machine condition monitoring specialist is a new important role in the service team. This member will typically be located at the main dealership location where, based on the customer's consent, the condition and performance of the machines are remotely monitored. When technical anomalies are identified, the specialist will proactively address them in collaboration with the responsible outlet service manager.

Concerning the third attribute—provision of training—the focus group discussions identified the need for training mainly in three areas. The first one is about technical training, which is delivered to the service team to develop the capabilities to use the remote service tools in different working scenarios. This helps ensure that the service staff can explain to customers the importance of John Deere Connected Support™ and its benefits for their machine field operations. The second area addresses people-oriented training to develop the skills according to the job position and level of responsibility. The last category relates to the organizational training mainly targeted at the dealer management as it is responsible for developing the required dealership capabilities for John Deere Connected Support™.

3.5 Service Culture

The innovative character of John Deere Connected Support™ drives the development of a strong service-oriented and customer-focused environment. These are two relevant attributes of a service culture, identified as one of the six implementation factors. Both attributes are reflected by the findings of the evaluation framework and the pilot dealers' workshops.

John Deere relates the service orientation to the cultural transition from a product to solution-oriented thinking, where the people's attitude is developed accordingly. To achieve this, it is important to adapt the dealership values and mission, as well as to further develop the existing service culture through supportive managerial behavior and internal marketing to promote a clear understanding of the smart service derived from John Deere Connected Support™. It is important to communicate and inform employees about the cultural transition. This can be accomplished through team events, field demonstrations, and a revision of the dealership's operating policies. All three ways represent a tangible approach to share the values of an innovative service culture in the practical context of John Deere dealers. Team events and field demonstrations offer employees the possibility to share their

feedback and to build a common understanding of John Deere Connected Support™.

The other attribute of service culture development is customer focus. Findings from both sources of information show that the delivery of a remote machine monitoring smart service can influence the customer's perception of the machine service received. The traditional service approach expects the customer to request a service like machine maintenance or repair. Through this smart service, a new level of customer experience is achieved since the John Deere dealer becomes more embedded in the customer's field operations, moving from a transactional basis where machine service activities are executed as single events to a relationship basis where proactive customer service is delivered throughout the product lifecycle. The pilot dealers raised the importance to first demonstrate to customers the advantages of a proactive service approach enabled by John Deere Connected Support™. This facilitates a new mindset among customers, which is something that needs to evolve gradually, regardless of the type and size of the customer. A vital aspect is to ensure a solid collaboration between the customer and the dealer in realizing the value of John Deere Connected Support™. It can be initiated when the customer provides his consent for the machine data processing, required for remote machine monitoring. On this occasion, the dealer can explain how this smart service works, illustrating its values for customer field operations.

3.6 Service Quality

The remote machine monitoring smart services, as well as traditional services, are equally influenced by different dimensions of service quality, which need to be considered to ensure successful and sustainable service delivery. High service quality is critical for promoting a proactive service approach and meeting customer expectations. We identified two attributes in this regard: performance measurements and delivery competencies.

The pilot dealers highlighted two practical aspects concerning performance measurement. First, customer satisfaction is considered as a key metric that can be measured by comparing the satisfaction of customers who are benefitting from a proactive service approach versus those customers who have not yet experienced the value of John Deere Connected Support™. Second is the definition of a metric to quantify the service delivery rate. Specifically, it is necessary to assess the validity of the smart service delivered to the customer by monitoring the efficiency of the operating process and its consistency. This metric relates to the second attribute of service quality.

The delivery competencies were considered during workshop discussions as playing an important role in ensuring the desired service quality. The typical service delivery is characterized by a face-to-face approach, ensuring the physical appearance of the service received and, thus, the customer's quality perception. The provision of a remote machine monitoring smart service includes the use of technologies implying a remote servicing setting with a decrease in human contact,

especially in the initial stages. In this scenario, it is even more important to ensure customers get the expected perceived quality, avoiding that a misleading interpretation of the service setting may cause a customer's hesitance. To ensure a high level of service quality, even in a remote service scenario, specific delivery competencies are developed by the pilot dealers. In this regard, three main areas are identified: first, ensure a solid knowledge level and background within the service workforce through dedicated training; second, establish a checklist to ensure consistency in the smart service delivery; and last, leverage service administration applications to manage the entire service delivery process.

3.7 Summary

The results of the evaluation framework and workshop discussions were presented and discussed in the previous chapters according to the six success factors identified for the dealer implementation of John Deere Connected Support™. To provide a comprehensive overview, all resulting factors and attributes are reported in Table 1.

Table 1 Factors and attributes for John Deere Connected Support™ implementation

Factors	Attributes
Management commitment	• The personal involvement of managers in the implementation • Execution plan definition • Customer value proposition • Support the necessary organizational changes
Organizational structure	• Coordination of the service workforce • Creation of a centralized service team • Integration with the existing service practices
Operational structure	• Definition of a specific operating process • Cooperation among all dealer's departments • Gains in working efficiency • Information-sharing on service activities executed
People	• Innovation in the required skill set • Recruitment of dedicated service personnel • Provision of technical and non-technical training
Service culture	• Service orientation as a solution provider • Information about the cultural evolution • The customer experience of smart service received
Service quality	• Performance measurements for customer satisfaction and operating process efficiency • Service delivery competencies

Source: Own research

4 Conclusion

The exploratory approach defined and conducted by John Deere has been instrumental for the successful implementation of John Deere Connected Support™ across the John Deere dealer network. Specifically, the evaluation framework created by John Deere ensured an initial exemplification of the implementation factors, providing robust guidance to start exploring this new space. During the workshop discussions, the pilot dealers consolidated the success factors by identifying attributes that are relevant to relate the success factors to the service setting and the practical context of the dealer's after-sales service organization. Indeed, the driving considerations for the actual implementation of John Deere Connected Support™ at the dealer level emerged mainly from the workshop discussions. Three key considerations are, therefore, derived.

First, even though the agricultural equipment industry is still approaching the actual provision of smart services to the end-customers, John Deere dealers already have the necessary business confidence and capabilities to continue their implementation.

Second, exploring the implementation of smart services should go beyond the equipment manufacturer's service organization and focus on all actors involved in the service network, like John Deere dealers. This should be done to foster a collaborative approach and support activities with the ultimate goal of delivering value to the end-customers.

Third, the identified success factors delineate more organizational aspects and less technical or technological aspects. Thus, the dealer implementation of John Deere Connected Support™ relates primarily to developing the necessary organizational competencies. This setting represents an opportunity for John Deere dealers to further leverage their capabilities, pioneering into the mentioned space.

As John Deere is transforming from a machinery company to a smart technology company, it is fundamental to continue the after-sales service innovation, which has been triggered by the John Deere Connected Support™ initiative. It includes the sales force engagement, and further integration of customer needs as smart services represent a new level of service experience for John Deere customers.

SKF: Rotating Equipment Performance, a Shift in Perspective—From Transactions to Outcomes

Philipp Schmid

1 Introduction

AB SKF (Swedish: Svenska Kullagerfabriken, which is translated as "Swedish Ball Bearing Factory" in English) is a Swedish bearing and seal manufacturing company founded in Gothenburg, Sweden, in 1907. The company both manufactures and supplies bearings, seals, lubrication and lubrication systems, maintenance products, mechatronics products, power transmission products, condition monitoring systems, and related services globally.

When it comes to business models, there exist different types of business. SKF offers direct and indirect business via distributors and sales to original equipment manufacturers as well as to end-users. Additionally, SKF serves various industries from automotive, railway, wind, metals, and other industries. As part of a strategic initiative, two value propositions were created: Products and Rotating Equipment Performance.

The Rotating Equipment Performance (REP) proposition meets the needs of customers who operate critical machinery by maximizing performance. The offering includes performance-based contracts, implying that machinery performance determines the remuneration.

From inception, SKF has been an innovative company, plowing a different path and business model than conventional industries. The company began with the invention of a double-rowed, self-aligning ball bearing design that solved the constant misalignment issues the mill in which the founder was working experienced.

Due to the misalignment problems the mill (and others in the area) had, their machinery kept catching on fire, resulting in a costly halt to production. As a result, insurance companies were reluctant to provide these industrial factories with

P. Schmid (✉)
SKF Group Headquarters, Gothenburg, Sweden
e-mail: skfweb@skf.com

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coverage. So, when Sven Wingquist, the founder, invented the SKF self-aligning bearing, instead of selling them to the industries, he proved to the insurance companies that they solved the root cause of the fires. As a result, the insurance companies extended coverage to the textile mills with one condition: They had to buy and use the new SKF bearings.

2 Initial Situation

In general, there is an industry trend toward cheaper manufacturing, which means that there is pressure to produce at lower production costs. At the same time, the products produced in these plants see a shorter technology life cycle.

When it comes to sales, there is a shift from a product perspective toward service, value, and the outcome of a product. Customers increasingly prefer buying the outcome (e.g., transportation) instead of owning the product (e.g., car/truck). There are no single purchases anymore. Customers buy a flat rate.

For SKF industries, especially in process industries like steel production, pulp and paper, mining and mineral processing, and many more, bearings are considered spare parts. Once they break down, they are replaced. Bearings are purchased by availability and cost.

Under these circumstances, the customer and supplier are driven by different things and, inherently, cannot work together to achieve a better outcome. Purchasers are focusing on price reduction through hard negotiations. Suppliers try to keep price levels high. With this, there is less room for improvement and collaboration.

However, when a more in-depth understanding of customers' KPIs is known, it helps find better solutions.

SKF generally began like most manufacturers—make and sell the equipment—but with an emphasis on end-user productivity and energy efficiency. However, over time, and as an industry leader, it shifted from a manufacture-and-sell model to a Rotating Equipment Performance (REP) model and now also offers an equipment-as-a-service model (or a Rotation for Life program).

The REP model provides clients with performance-based contracts. It enables the client to plug into its vast database and connect with the company's pool of experts to access data-driven insights into the client's machine's performance from wherever he pleases and solve problems fast.

The SKF REP cycle consists of five key phases:

- Assess
- Detect
- Maintain
- Solve
- Rebuild

A client's needs and pains usually fall into one or more of these categories simultaneously, and, whatever the case, SKF moves to rectify it to ensure a smooth operation on the part of the client.

In its Rotation for Life program, SKF focuses on meeting performance targets agreed upon by a client and SKF for the client's critical rotating equipment. To do this, SKF selects the right products and services for the client's equipment and works to ensure a smooth operation of the client's rotating machine. The goal of the Rotation for Life program is to implement a customized REP strategy for its clients. This REP strategy covers the full range of SKF products and services. Furthermore, instead of billing clients per transaction and purchase of products, SKF enters into a long-term, performance-based contract in which it collects a fixed monthly fee (Svenska Kullagerfabriken [SKF], p. 7). This allows customers to move from a capital expenditure (CAPEX) model to an operational expense (OPEX) model.

3 Solution

The idea is to create an individual value proposition for customers based on their KPIs and shared understanding. A structured approach is the value proposition canvas from Osterwalder. Within this concept, the customers' jobs to be done, pains, and gains are described. On the supplier side, there are pain relievers, gain creators, and products and services.

Finding an individualized value proposition takes time, but it is a solution that better fits the customer's needs and the supplier's portfolio. The first value proposition needs to be taken into a contract. This can be a challenge as the proposed service or product might not fit the standard terms of services that are in standard legal documents from both sides.

A first value proposition or contract could be considered a hypothesis. Based on feedback, even better value propositions can be evaluated. This is very often a service rather than a product. In the end, a customer needs a result. A product is a means to achieve this and not always the only solution.

Some of the benefits of the Rotation Equipment Program are as follows:

3.1 Improving Output

The REP helps increase machine availability, performance rate, and quality—all of which help boost a client's business output.

3.2 Trimmed Total Cost of Ownership

The total cost of ownership (TCO) is not just the capital spent on buying equipment. Unplanned downtime, energy usage, maintenance, spare parts, and even labor can all

contribute. Improving performance with SKF REP can help a client's business save in all these areas.

3.3 Use Digitalization to Increase Uptime

SKF Enlight Centre dashboards provide unique data insights on the client's machinery. Connection to expert machine diagnostics aids the client in detecting problems on the go, and before they badly affect critical machines. The customer also accesses a vast store of data to provide the business insight needed to transform the way business is conducted and machines maintained. The client can store and share data from his entire business in the SKF Cloud. With digitalization, clients can increase company agility, safety, reliability, and sustainability.

3.4 Reduced Reliance on Scarce Talent

Save time and cost of recruiting, training, and retaining people with scarce and expensive skill sets. SKF is an expert partner that can be called on at any time. It boasts all the talents a client needs and more, thereby eliminating the need to hire new talents or expend more resources training and retraining them.

3.5 Safer Operations

Reduced downtime from incidents allows increased productivity and performance. SKF can help make one's ways of working safer as well as navigate EHSS regulations.

3.6 Increased Sustainability

Increased sustainability reduces energy consumption, waste, and spare parts to save costs while delivering to meet sustainability requirements.

3.7 Data-Driven Decision-Making

At the heart of the REP, for customers, data-driven decision-making is harnessing all of SKF's technologies, domain knowledge, digital capabilities, and the vast store of data to make better business decisions from the interpretation of that data. SKF (SKF, p. 4) says that it boasts the ability to link into customers' digital ecosystems and also link its customers to her REP Centre dashboards from where they can interpret the data they have access to.

The business landscape has completely changed. In this current age of business, to thrive in any industry and become IIoT and industry 4.0 aligned, businesses have to make decisions based on well-interpreted data rather than guesswork. According to Gottdenker (2020), "data-driven insights are the new gold" and can put you ahead of your competition. However, to have such valuable insight, one would have to collect Big Data and build data competencies that will enable them to turn the data collected into financial and operational growth. Many organizations lack the time and resources needed to collect Big Data or the technical know-how to collect and turn them into useful AI-driven industrial analytics.

Moreover, there is a world of difference between data and information. Many companies invest heavily in collecting data but have been unable to process that data into useful information and insight for business and revenue growth. When we look at companies right now, only a minority of data is collected. This represents a considerable waste.

Several obstacles stand in the way of making data-rich decisions. Two major challenges to implementing Big Data initiatives are:

- *Lack of proper knowledge regarding the right variable to track*: For many, the right variables to track for proper business and machine operation are still guesswork. Moreover, without even knowing the right variable to track, analyzing the data tracked becomes a challenge.
- *Lack of skilled data scientists*: The data scientists needed to track and analyze Big Data for most companies are simply insufficient because many organizations do not have the resources to support as many scientists as required.

Several more challenges exist, including insufficient business intelligence tools and problems with the hygiene of the data collected. Without Big Data, artificial intelligence-driven industrial analytics is a massive challenge because data fuels AI-driven analytics.

In light of all these challenges faced by many SKF customers regarding the collection, analysis, and interpretation of data, the SKF REP business model is the best solution. With over 110 years of experience and data collected and analyzed, its solutions are suitable for its industries. When a customer connects using a solution like the SKF Enlight Centre, he has access to all this data and can make meaningful interpretations for his business and machines.

SKF draws on this rich data and information to deploy AI-driven customer-centered solutions. The company can, for instance, deploy data- and AI-driven condition monitoring of a customer's critical machinery to ensure they are in proper working conditions, detect problems (or potential problems) early, and solve the problems for the customer. It can carry out proper maintenance of a customer's equipment and remanufacture where necessary.

Some of the services that SKF can provide her customers to ensure they make data-driven business decisions because of her rich store of data and AI-driven solutions include:

1. *Engineering knowledge*—benchmarking, understanding customers' needs and opportunities for improvement, application expertise, ensuring performance, and KPI targets
2. *SKF Digital Platform*—secure and easily accessible data storage, IoT, and Big Data analytics
3. *Data collection*—including condition monitoring data, lubrication, maintenance, process, production, and spare parts
4. *Actionable insights*—visualization through dashboards to support decision-making and actions in real time that optimize asset performance and KPI measurement.
5. *Supply chain*—real-time info on the spare parts for specific machinery, enabling a new and more efficient spare parts management and supply chain
6. *Predictive maintenance*—utilizing remote diagnostic resources and system-based tools
7. *Field maintenance*—a full range of maintenance support services
8. *Remanufacturing*—identifying when to perform a cost-efficient remanufacturing process while reducing carbon footprint and optimizing the life cycle cost of the assets

3.8 Artificial Intelligence Services and Condition Monitoring

Wireless condition monitoring and the ability to interpret the data generated by machinery and components is a cornerstone the SKF REP offers. The SKF Enlight AI, for example, is an industrial analytics solution based on AutoML (automated machine learning). It works to complement existing condition monitoring, including SCADA.

Here is how it works:

Industrial machines have hundreds to thousands of sensors permanently collecting assets' data. If technicians were to inspect machines to collect this data manually, they would be lost and unable to detect the data necessary to forecast a machine breakdown and prevent unscheduled downtime. (By the way, the cost of unscheduled downtime to the global process industry alone is about $20 billion, according to Glazer (2020).) Technicians would have to rely on a lot of trial and error to determine the root cause of failure in order to restore production. According to Glazer (2020), an estimated 17 days of unscheduled downtime per year result from executing failure root cause data collection this way.

However, with a system like the SKF Enlight AI continually analyzing the data produced by the thousands of sensors and checking for irregular data patterns, the system can detect upcoming machine failure and alert technicians long before manual threshold conditions are ever breached. This is because the automated machine learning is super-efficient at sifting through the enormous data to decide the optimal algorithm for analyzing the data stream.

The AutoML-based SKF Enlight AI has self-learning algorithms that continually analyze Big Data the asset sensors sent. From the data, it can detect any anomalies

and also provide technicians with real-time alerts of machine condition and any upcoming machine failure. The alerts provided to technicians are in user-friendly formats that they can understand.

With such condition monitoring in place, operation and maintenance repair staff are presented with specific knowledge of the particular sensors that detected anomalies. This allows them to establish the root cause of machine failure faster and speed up the remediation process (SKF).

Not only is SKF Enlight AI based on the leading edge AutoML technology, but it also takes advantage of the expert knowledge of SKF's diagnostic services. It can provide highly scalable predictive maintenance services that are cloud-based and do not require the clients to install any software or hardware for its deployment (SKF). Clients are not just presented with the ability to identify problems beforehand; they are offered a solution to resolving those problems and guidance on how to prevent future occurrences.

Artificial intelligence services and condition monitoring using the SKF Enlight AI center help prevent not only unscheduled downtime but also labor costs and overtime, labor repair costs, damaged production output, excess inventory, and other variable costs, among others.

A concrete example is a steel manufacturer. The company relies on continuous equipment uptime to meet their production goals. Failures of critical rotating machinery cost millions. This REP agreement created a true partnership to achieve best-in-class productivity. Catastrophic failures can be avoided by identifying issues early in critical rotating equipment and implementing solutions that minimize downtime. Detecting problems early allow for streamlined inventory orders and well-planned maintenance activities that reduce costs, improve worker safety, and boost productivity.

Figure 1 summarizes both the services and the journey that SKF has undergone toward performance and servitization. The SKF bearing products and adjacent technologies are all digitally connected.

4 Conclusion

It is highly recommended to invest time in better understanding customers' jobs to be done, pains, and gains. One needs to be open to listen to the customer and not come with an existing product portfolio. Two example cases to illustrate the importance of customer-specific solutions and how it can be beneficial to customers follow.

The first is a situation where SKF had to remanufacture products at a coal-fired power station. SKF states that the company had discovered that six of their roll wheel bearings needed to be overhauled because they had been pulverized. SKF went on to assess the machines. After a successful inspection and failure analysis, it concluded the bearings could be restored despite the damage to them. So instead of taking 7 months' lead time to replace the bearings with new bearing sets, SKF remanufactured the bearings in 6 weeks. As a result, the company saved more than 12,000 Australian dollars in new bearing purchases. Another 1.5 million

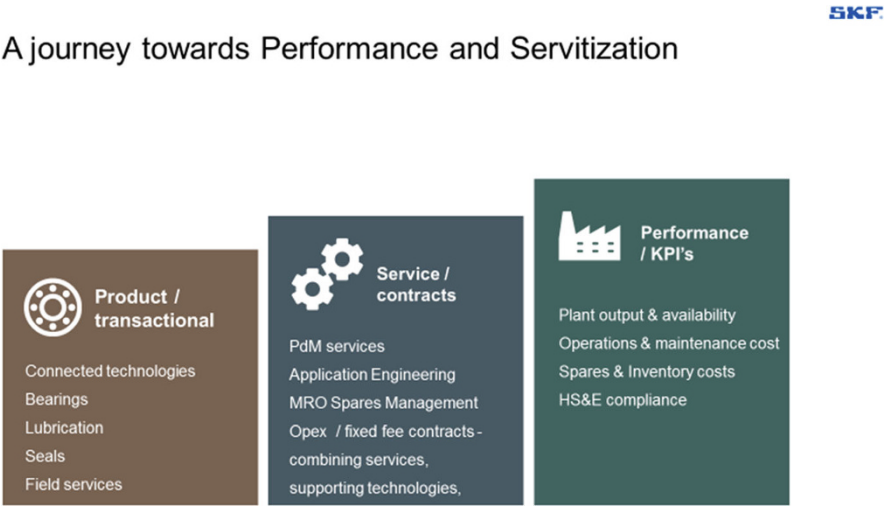

Fig. 1 Journey to Servitization. Own illustration

Australian dollars (the approximate amount of 5 months' worth of lost revenue resulting from reduced power production had new bearing sets been required) was also saved.

The second example case illustrates the importance of delivering customer-specific solutions. It comes from SKF's partnership with a pulp and paper manufacturer in Europe (SKF). In this case, SKF deployed its maintenance-related services for this manufacturer, forging a long-term maintenance partnership program. The result and benefit of this partnership to the manufacturer was a 45% reduction in bearing spend and a 55% reduction in downtime in 7 years. In the first 12 years of SKF introducing a condition monitoring solution system, the company also experienced a 75% increase in productivity. Ultimately, the company achieved a 99% reliability target after 17 years of partnership.

Had SKF only focused on the manufacture and sales of products rather than deploying solutions that were tailored to customers' pains and needs, it would not have been able to help these companies save and achieve the money and target it helped them save and reach, respectively. SKF realizes that it is no longer sensible to only sell products as singular solutions. It continues to evolve into offering packages that incorporate several product offerings and the knowledge and expertise it boasts.

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Value Co-creation as Key to Customer Satisfaction in Digital Services Sales

Rubén André Lorenzo

1 Introduction

Efficient, safe, and green transport systems are indispensable for many areas of human coexistence and the economy. Rail transport contributes significantly to this. Simply getting from A to B quickly and efficiently is presupposed nowadays. But passengers expect more, and cities, operators, and industry must respond to this. As a provider of overall solutions and also as a system integrator, Siemens Mobility bundles all the necessary competencies and is thus able to fulfill passengers' wishes with the help of innovations. This is done by equipping the providers of the transportation systems with the means to make optimal use of their infrastructure and vehicles.

The constantly increasing demand for mobility requires efficient traffic concepts. Siemens Mobility is constantly developing new intelligent mobility solutions that increase the availability of rolling stock and rail infrastructure, optimize route utilization, and hence create a new quality of travel. By electrifying, automating, and digitalizing infrastructures and vehicles, the company is setting standards for the mobility of the future.

In recent years, Siemens Mobility has focused not only on traditional but also strongly on digital services. Whether it is guaranteed availability, maximized throughput, or the realization of new business models, digital services from Siemens Mobility deliver all of this. From sensors and intelligent algorithms to precise analytics, Siemens Mobility offers the entire basis for optimized maintenance and operation—underpinned by decades of practical experience of the experts in rail transport. The foundation for digital services is "Railigent," the application platform for smarter asset management. Railigent is providing monitoring, analytics, and

R. André Lorenzo (✉)
Siemens Mobility AG, Wallisellen, Switzerland
e-mail: ruben.andre@siemens.com

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predictive services, and at the same time, it is an open platform for partners as well as customers, with over 130 projects and over 80 customers worldwide.

Our comprehensive solution portfolio offers ready-to-use solutions/applications as well as individually tailored solutions for our customers. Our digital service organization works closely with our customers to offer reliable solutions in a fast and agile way throughout the entire life cycle of the assets (stock and rail infrastructure). To achieve this, digital services have their own sales structure. The reason is to have dedicated sales resources to enable the company to create new services in close cooperation with the projects, customers, and partners.

Customer value co-creation is not in itself a newly developed method. As early as the end of the 1980s, people started using co-creation to involve the customer in their production. At Siemens, the methodology experienced a revival when the trend toward digitalization kicked into gear. In the traditional business, people were sure which proven sales channels used to work. This was not any longer the case in the new era of digitalization. To develop the right solutions and services for the customers and to bring them to the market, co-creation was and is the tool that allows us to involve the customers directly. In the beginning, the company focused on customers who were already prepared and knowledgeable to participate in discussions in the field of digitalization. Furthermore, the sales competencies of Siemens had to be expanded. While in conventional and traditional business, the salespeople have to be sophisticated with rather pushy communication, co-creation is different. It is absolutely necessary to listen to and understand customers' pains and take on a more consultative role. In the past, companies welcomed customers into a showroom to demonstrate the products available for selection. Today, they are invited to the Digital Lab. But nothing is shown there anymore, and the products are not necessarily already marketable or even existent. The goal now is more about developing and creating the future together. New technologies, such as digital whiteboards and writable walls, are available, which allow the co-creation process to be carried out more easily and creatively.

2 Digitalization Changes the Way We Work, Do Business, and Interact

Transporting goods and people by rail is one of the great innovations in history. The rails themselves cannot be digitized, but the rest of the business faces the effects of the digital revolution. The digital transformation is changing the competitive environment. In the case of the transport sector, this is taking place on four fronts: the transformation of the customer experience, the transformation of operational processes, employee training, and the transformation of the business model. Some of the innovations we hear about today in different contexts have already been introduced by the railways for some time now, but the mobility sector is moving toward new challenges. Here is one example: Today, there is much talk of connected and autonomous cars, something that in passenger rail transport has been a reality for many years now.

Nevertheless, digitalization provides the advantage of using new technologies in our industry. The capabilities offered by data analytics, artificial intelligence, cloud, and platform technologies, as well as cybersecurity, play an important role in digital services. But the key question we are facing daily is, how do we create value for our customers with these fancy technologies? Notably, customers in our B2B industry are also asking themselves how digitalization affects their business. As a result, customers, as well as suppliers, are experiencing very similar challenges during the current digital age. It must be taken into account that customers have uncertainties in the digital era. These uncertainties can be reflected by various questions such as the following: "What is the impact of digitalization on my business?", "How do I develop new competencies to be successful with digitalization?", "Is my supplier the right partner to accompany me in the digital era?", or "How do I earn money with digitalization?"

Sales capabilities must shift from selling products and features to becoming trusted advisers for innovation. Only in this way can we face the aforementioned challenges and help customers find answers to their questions. Thanks to the expansion of the collaborative economy, new ways of doing business and relationships have emerged through the exchange of goods, services, and even knowledge. This new system of relationships, based on trust and collaboration, is significantly impacting the way companies engage their customers in their innovation and sales processes.

The best way to generate value and sell digital services is to involve customers and partners in the process of creating new services. Who knows most about the products we have sold, if not those who consume, use, test, and recommend them? Obviously, our customers. And, therefore, collaboration is much more efficient than the competition.

The term behind our methodology is "co-creation." Co-creation is a modern and effective way to adjust smart services to the customers' needs. In addition, co-creation is the activity of jointly creating win-win solutions with prototyping and rapid business impact. The term "co-creation" is widely used in the world of marketing and innovation. It describes a special behavior of companies who by this means enable their customers to improve their service in such a way that the final result is something that is perfectly adjusted to their business objectives and using all the insight of those who contributed to the solution.

Co-creation has been consolidated as a practice that can be applied to diverse scenarios and that, within a business environment, can be defined as the collaborative exercise through which companies work hand in hand with their customers for different purposes, for example, designing new services.

3 What Are the Triggers for Co-creation?

It has been demonstrated that the success of new services and innovations depends on understanding the needs of the clients and the business impact of those needs on the one hand and the required efforts to meet these needs on the other hand.

However, this process is usually difficult because the requirements of customers are complex and cannot always be identified through the traditional methods of market research. The failure of many new services lands on the inability of companies to accurately identify and meet the needs of their customers. To avoid this, Siemens Mobility involves customers more actively in the process of developing innovations. This decision is also based on findings from cognitive psychology, postulating that the intrinsic needs of the human being are more likely to be met if he or she is involved in creative activities. Thus, co-creators can enjoy psychological benefits that would not have been reached with a "standard services sales" approach.

Even though the advantages are quite outstanding, it is important to consider and know the challenges and risks of co-creation. First of all, it is important to consider, and experience shows, that people, industries, and organizational cultures will not change quickly. For this reason, it may well be that it takes a lot of time and patience to establish a co-creation culture in an organization. The co-creation concept can challenge the mindset of managers. Sometimes the mindset of the people in the organization has to be changed to the perspective of an external customer or partner, which is not easy.

In the process itself, companies must filter the ideas of their customers. Sometimes in customer workshops or meetings, the number of suggestions and inputs is immensely high. The challenge will then be to identify the right ones from the flood of information to develop them further in our own organization. During the selection process, care must be taken that the customer does not get the feeling that something has been ignored or forgotten. An iterative process involving customers can counteract this problem.

4 "Customer Value Co-creation" as a Means to Drive and Scale Digital Services

Combining our customers' business ambition with Siemens' leading domain and technology expertise by applying value co-creation methods enables us to generate new service businesses together with our customers. Consider the following concrete example. One such customer, who is part of the Swiss railway industry, had the impetus to create more transparency on his fleet operations, to reduce the overall cost of ownership. We partnered with him to design and build a new service that does what it is supposed to do. With this transparency goal in mind, we brought together the customer's operations management, including operational personnel, with Siemens' subject matter experts and data scientists for an assisted sequence of workshops. The workshops drew on our customer's expertise and experience in their business and the processes of their operations.

The first step was to understand the present situation and generate ideas (cf. Fig. 1). This step focuses on the customer's barriers and gains. We have been good at not thinking about the future service in this step, but to first discuss the current situation. It is important to analyze the present from different perspectives together with the customer.

Fig. 1 Customer value co-creation framework. Own illustration

During the second step, it is important to create a value proposition. The purpose is to identify and detail the specific operational challenges and value drivers. This second step is usually executed by the service provider.

In the third step, the value creation logic is then reviewed together with the customer. If the customer's decision is positive, design and prototyping are directly carried out. We commonly apply agile development and rapid prototyping to jointly create working software on our rail specific analytics platform, "Railigent."

With Railigent and corresponding machine-learning mechanisms, the forecasting systems are constantly being further developed. Siemens Mobility uses it to map the complete path of the data from the sensor on the track to the report within an application—including recommendations for action.

The data is analyzed at the Siemens Mobility Data Services Center in Munich Allach (Germany), which today services over 3000 locomotives and train sets in Europe. This generates considerable amounts of data. It is assumed that a fleet of 100 multiple units produces between 100 and 200 billion data points annually, meaning that a fleet of trains generates around 50 terabytes of data.

Diving deeper into the details, we developed a dashboard on Railigent to help the company's teams visualize the distance traveled by the fleet and distinguish between frequent and less frequent assets. This way, the economic consequences of maintenance planning become more transparent and available to the operations planning team daily.

To achieve this, Siemens combines existing sensor data from the customer with our algorithms. With these insights and the knowledge of available asset capacity, the customer's operations teams can better optimize their fleet dispatching as an additional benefit. The customer is currently piloting the software prototype. Once approved, the application can easily scale to cover the entire fleet, resulting in the last important step of the co-creation methodology: implementing and scaling.

During the co-creation workshop, the customer was invited to our Siemens Mobility Data Services Center, where it was possible to discuss their pain points and understand the challenges we have to solve. Their feedback provided the

necessary insights to succeed. The data scientist must work on the customer algorithm to receive direct feedback from the customer. This approach avoids the Chinese whispers effect, and the feedback can be directly translated into success. The co-creation workshop cuts off months, or more, of the time and—attendant costs—of a more traditional development approach. During the workshops, everyone who mattered was literally in the same room to compress these cycles into just days. Instead of having to shape large services and risk considerable investments to evaluate a service value logic, the team could make slighter, more speedy iterations and assess with the customer if the resulting new service is meeting the expectations, before committing to deploy it to scale.

5 Why All Should Apply the Co-creation Principle?

Co-creation is a methodology of expanding new services, innovation, and the capacity to value creation of the company, through nurturing the relationships with customers and reducing marketing, research, and development costs. As a result, besides Siemens, more and more companies are adopting strategies that allow them to co-create with their stakeholders to grow with new services, products, or solutions.

Here are some benefits for the customers resulting from co-creation processes:

1. The customers get a service tailored to their needs since it is the customer who designs or chooses the service, product, or solution that will be introduced in the market.
2. Customers have an opinion. They feel more valued when they are involved in the process of creating value.
3. Customers can interact both with the company and with their own customers.

The benefits obtained by companies using co-creation are the following:

1. *Increased productivity:* Since all participants are sitting in one room, time can be saved, crucial questions can be clarified directly, and errors can be eliminated.
2. *Improved service quality:* The customer receives high-quality services, as these have been developed to meet his requirements.
3. *Improvement in customer satisfaction*: We put the customer in focus, and we listen to our customers. Therefore and because of the specific service for the customer, satisfaction will improve.
4. *Risk reduction:* Due to the participation of the customer within the whole process, misinterpretation or bad design of a solution can be excluded, and the risk of delivering anything unwanted is reduced or even non-existent.

Possible risks and challenges using the co-creation methodology:

1. People, industries, and organizational cultures will not change quickly. It will take time for people to become open to experiencing this new approach.
2. Understanding the customer world needs an internal mindset and culture change; this requires time and patience.
3. The quantity of information could be high. It will be challenging to select the right information and not to lose the customer during the process.

Due to the increase of digital products and services and the importance of understanding the unconscious needs of customers, customer value co-creation will play a crucial role in the future. The unconscious needs that customers are unable to articulate are brought to the surface, defined, and expressed using the method described above. The advantages of the customer value co-creation method are very pronounced. The company's sales team will have to learn this new methodological competence in the short to medium term to remain competitive in the market. Companies can address existing and potential new customers and interact with them. They can test new offers for acceptance at an early stage and at the same time build an early fan base. And they can develop market potentials that only arise through the close partnerships of customers and technology providers.

In summary, companies should ask themselves if they want to continue carrying out a practically one-way sales relationship with the customer or, in contrast, as described above, if they are willing to make the customer the main protagonist of a project.

Applications of a Digital Twin for the Use of Compressed Air Stations: Concepts and Methods for Model-Based Automatic Planning, Design, Control, and Analysis of Compressed Air Stations

Florian Wagner

Compressed air stations are planned individually for each customer and adapted to the specific process supplied with compressed air. Thus, no two compressed air stations are alike, although the components of compressed air stations are standardized products: The combination and interconnection of these standard components make each compressed air station unique. On the one hand, the rapidly increasing digitalization of systems and the information processing capabilities that are applied within them also offer compressed air system suppliers such as KAESER KOMPRESSOREN SE new and attractive opportunities for the (semi)automatic planning, control, optimization, analysis, and diagnosis of compressed air stations. Also, new business models, like pay-per-use, become possible or can be implemented in a more reliable way. On the other hand, the great variance of compressed air stations poses special challenges, particularly with regard to the efficient creation of static and dynamic digital twins of compressed air stations by staff who do not have expert knowledge of modeling cyber-physical systems. This chapter provides an insight into the adopted processes and the technical solutions that KAESER KOMPRESSOREN has developed to meet these challenges.

1 Company KAESER KOMPRESSOREN

A family-owned company, KAESER KOMPRESSOREN, is one of the world's leading manufacturers and providers of compressed air products and services. Established in 1919 as a machine workshop, Kaeser currently operates two manufacturing sites in Germany. The company employs approximately 7000 people worldwide.

It manufactures its products at facilities in Coburg (northern Bavaria) and Gera (Thuringia), Germany. Kaeser products stand out for their remarkable reliability,

F. Wagner (✉)
KAESER KOMPRESSOREN SE, Coburg, Germany
e-mail: florian.wagner@kaeser.com

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energy efficiency, cost efficiency, and ease of maintenance—all of which help the company achieve its top priority: complete customer satisfaction.

To support this, KAESER KOMPRESSOREN offers a wide variety of services for the planning, operation, and maintenance of compressed air stations, which is the context where compressed air products are being operated in. These offers include cutting-edge services based on pay-per-use like SIGMA AIR UTILITY (operator model for compressed air stations) and SIGMA SMART AIR (service contract based on the utilization of products), which are largely driven by new possibilities that arise due to the digitization of processes and systems.

One key factor for KAESER KOMPRESSOREN's success is that these services are not focused on the individual product but the overall system the product is being operated in. This allows KAESER KOMPRESSOREN to implement a holistic approach where efforts for optimization in planning, operation, and maintenance take the overall system efficiency and reliability into account, instead of doing suboptimal local optimization for the individual product.

Taking the overall system into account brings up new challenges with respect to digitizing the information about compressed air stations and compressed air products. This chapter provides some insight into how KAESER KOMPRESSOREN is tackling these challenges.

2 Introduction to Compressed Air Stations

Compressed air is an indispensable energy transport and process medium in many industrial applications. In industrial environments, compressed air is provided by corresponding compressed air stations. A compressed air station is a combination of components with different tasks:

- Compressed air generation (e.g., compressors)
- Compressed air treatment (e.g., dryers and filters)
- Compressed air storage (e.g., pressure vessels)
- Compressed air distribution (e.g., valves and pipelines)
- Automation technology (e.g., cross-machine control)

Due to the complexity of compressed air stations, which are often housed in specially designed rooms, details of a compressed air station must be taken into account not only during operation but already in the planning phase of industrial plants or processes.

Each compressed air station is individually planned and adapted to the temporal behavior of the compressed air consumption of the process supplied with compressed air in order to deliver optimal results in terms of energy efficiency, cost efficiency, and availability. Customer-specific requirements need to be taken into account, which is constantly increasing, especially in terms of improving the systems' energy efficiency due to legal regulations. Thus, no compressed air station

is the same as the other. Each system is unique, although compressed air stations typically consist of standardized components.

Over the past two decades, more and more computer-aided tools, methods, processes, and automation solutions have been used in the planning, operation, and monitoring of compressed air stations to meet these increasing requirements.

As of 2021, high-end installations can be described as follows:

- Most components of a compressed air station are equipped with an electronic control system and can be networked via a bus system/network. This makes it easy to obtain state information (sensor values and derived values) from the components and to set operating commands to the components during the ongoing operation of the compressed air station.
- A master control system steers and monitors the operation of a compressed air station and its components in real time. Modern control methods are implemented as model-based (quasi-) optimization methods and can significantly increase the energy efficiency of a compressed air station.
- Usually, the master control system is also used to visualize the behavior of the compressed air station.
- For the planning of a compressed air station, the future dynamic behavior of a variety of possible planning variants/alternatives of the compressed air station and its components for assumed temporal behaviors of compressed air consumption is predicted (simulated), and on this basis, the variant with the most favorable life cycle costs is selected and realized.
- For the monitoring of compressed air stations, corresponding data is collected centrally and evaluated using analysis algorithms. This detects any problems in compressed air stations at an early stage and is used to plan repair and/or maintenance measures as a trade-off between the overall availability of the system and cost-efficiency.

Hence, data from the same compressed air station is processed for different purposes, in different systems, and at different times. They share the fact that data processing of the compressed air station takes place on the basis of a machine-readable image of the compressed air station. A machine-readable image is a model of the system, which can also be considered as a digital twin of the compressed air station. Figure 1 shows how a digital twin can be used at different stages of the life cycle of a compressed air station.

Here, a digital twin can be supportive in many places and used as an essential basis for each step in the life cycle of a compressed air station.

For a compressed air system provider such as KAESER KOMPRESSOREN SE, the organizational and technical challenges are to provide technical systems and technical processes for customer-specific compressed air stations that allow non-experts in the field of modeling to create digital twins from compressed air stations. This modeling by non-experts is necessary due to the huge amount of several hundreds to several thousands of individual compressed air stations installed

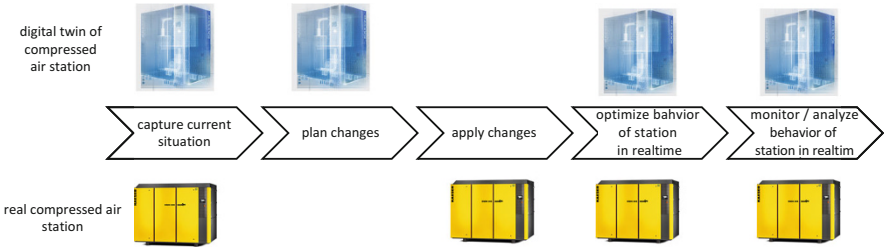

Fig. 1 Application of the digital twin at different stages of the life cycle of a compressed air station. Own illustration

per year, for which models or digital twins must be initially created and/or adapted (due to changes in the system).

An essential part of the modeling approach is recording the current conditions of the real compressed air station, which must be done on site. This can only be done efficiently and at acceptable cost by sales or service personnel, who visit the compressed air station for consultations or maintenance measures anyway but lack the specific knowledge in (mathematical) modeling. Using modeling experts for this task does not result in competitive pricing for the overall solution, as additional visits on-site with high travel expenses would be necessary. This is a major difference between compressed air stations and many other types of systems in the process industry (e.g., oil and gas), where the investment costs are significantly higher.

3 Key Challenges to Be Solved/Solutions

As a provider of the entire compressed air systems, the creation and application of digital twins face different and more extensive challenges than is the case with a pure component supplier.

3.1 Development, Creation, and Application of a Digital Twin

An important feature of a compressed air system provider is that he not only develops and/or creates the digital twin but also applies it himself. However, developers, creators, and users of a digital twin are often not the same person. Development, creation, and application do not necessarily take place for the same purpose, in the same system, and close in time. A major challenge for the extensive use of digital twins is, therefore, to manage digital twins, or the subcomponents they consist of, and make them available in a timely manner in different systems.

3.2 Reuse Parts of a Digital Twin

As mentioned above, a compressed air station typically consists of standardized components that are individually linked to each other. In the sense of reusing development work, it is therefore desirable not to develop a digital twin of a compressed air station from scratch again and again, but to build up already developed digital twins for the components of the compressed air station bottom-up. One of the challenges to be solved is to generate a library of digital twins for components and to ensure that their interconnection becomes possible in technically reasonable constellations by designing the interfaces of the digital twins.

3.3 Static and Dynamic Variants of a Digital Twin

When you enter a physically compressed air station, it becomes obvious at first glance that many components are installed and connected to each other via pipelines. With some introduction to the methodology, everyone succeeds in creating a static model of a compressed air station, which describes the structure of the compressed air station. An important representative of such a static model is the Process Flow Diagram (PFD) of a compressed air station, as shown in a simplified form in Fig. 2.

For example, a static model of a compressed air station can be used as an information base for the installation work. However, a static model of a compressed air station is not sufficient for the comprehensive application as a digital twin. For many applications or tasks, a dynamic model (in contrast to a static model) is required if the behavior (and thus something dynamic) of the system and its components need to be investigated with the help of a digital twin. The creation of dynamic models, usually described by hybrid automata and nonlinear differential equations, requires expertise in modeling and the underlying mathematical methodologies. One of the challenges, then, is to find a method that allows

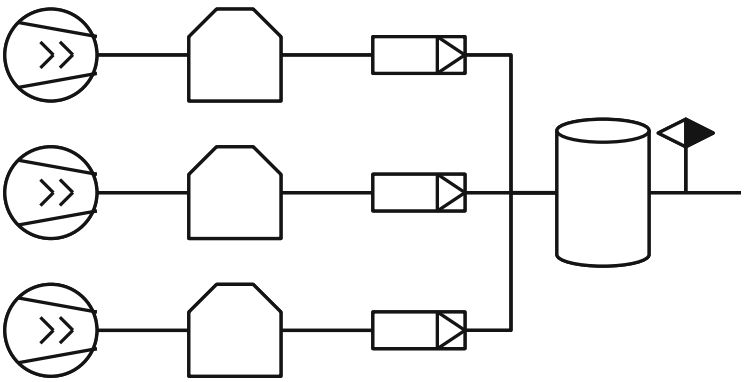

Fig. 2 A representative example of a greatly simplified Process Flow Diagram (PFD) of a compressed air station. Own illustration

practitioners in the domain of sales and service (i.e., non-experts) to create dynamic models of compressed air stations.

3.4 Standardization of Data

The application of a digital twin is, in a very abstract view, nothing more than a data processing step. Data (e.g., measured values from a real component in a real compressed air station) is fed to the digital twin; the digital twin processes the input, resulting in data again. One of the challenges that can be easily overlooked is to make the data available for data processing in the right format and especially in the right physical unit. It makes a difference of a factor of 100,000 whether you process pressure in the unit bar (bar) or in the unit Pascal (Pa). A pragmatic approach to this problem is to define a standard unit for each physical size type (e.g., pressure, temperature, speed) in which all data operations such as

- Capture
- Storage
- Transport
- Evaluation

take place. Only immediately before displaying a value to the end-user (e.g., operator of a controller) conversion from the standard unit to the user-specific unit takes place.

4 Process for Creating Digital Twins

An essential part of the solution developed by KAESER KOMPRESSOREN SE for the creation of digital twins is the process, as shown in Fig. 3.

The current state of an existing compressed air station is recorded during an on-site visit of a sales or service representative. Based on a database of component types (e.g., compressor, dryer, filter, etc.) and component IDs, a list of components of the compressed air station is created using a bottom-up approach, and the structure of the system (i.e., the piping of the components among themselves) is drawn in the form of a PFD with a special PFD editor as a progressive web app (PWA). Considering the limited size of a cellphone screen is a crucial requirement for a successful application.

In addition, the technical properties (e.g., electrical power consumption, delivery volume flow, maximum permissible pressure) are collected for each component. For Kaeser-owned components, an internal database is used for the technical properties, which eliminates the error-prone manual transfer of the technical data. In the case of products from other manufacturers, the technical data is read from the data sheets provided by the operator and recorded in a machine-readable manner. In this way, a machine-readable model of the topology of the compressed air station and a

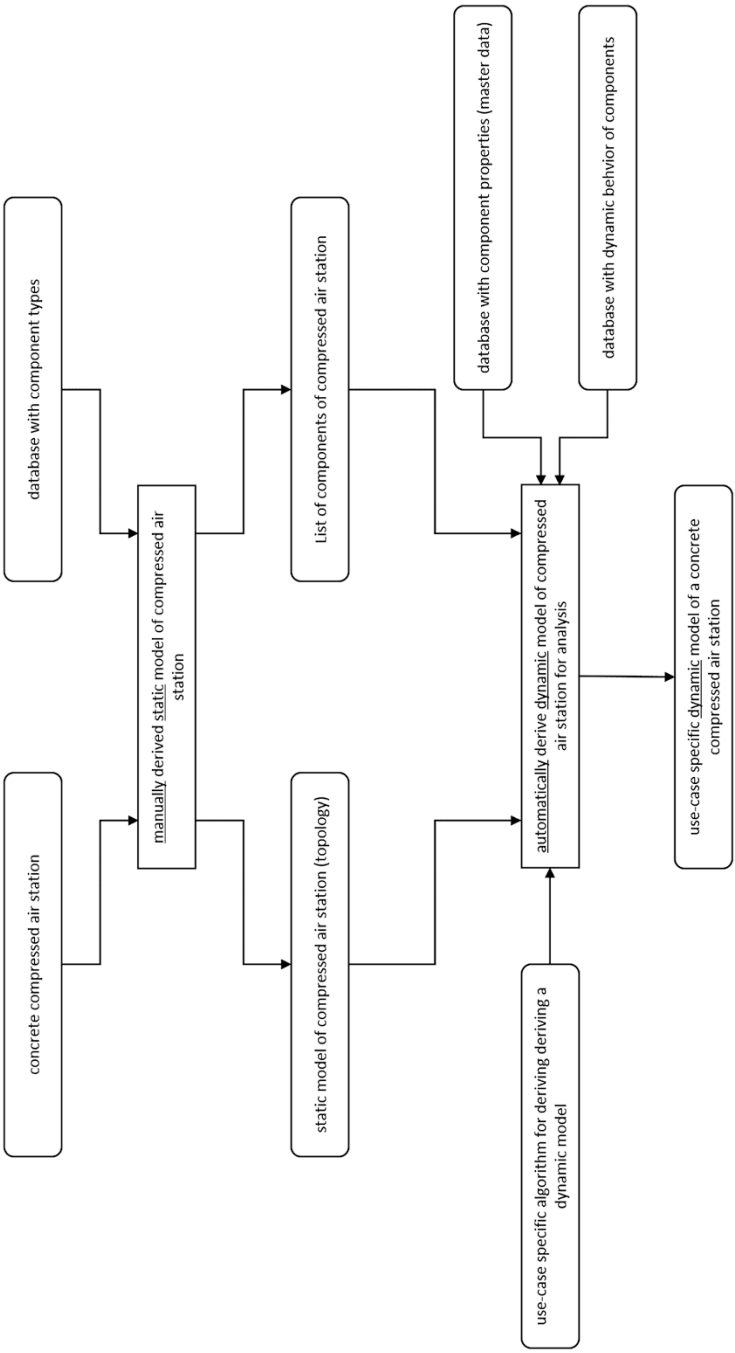

Fig. 3 Two-step process for creating digital twins in KAESER KOMPRESSOREN SE. Own illustration

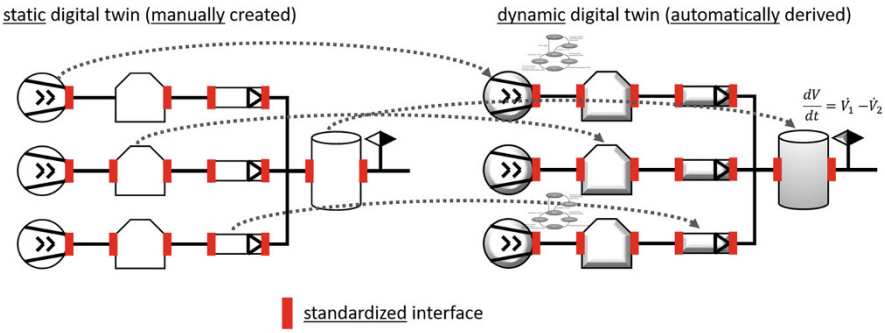

Fig. 4 Derivation of a dynamic model as a 1:1 image of components from the static model into the dynamic model of the compressed air station. Own illustration

machine-readable list of the components of the compressed air station and their technical characteristics are created. Both are stored in a Kaeser internal database for compressed air stations.

This first step of the two-step process provides a static digital twin of the compressed air station. As described above, static digital twins are not sufficient for many interesting use cases, as one wants to analyze the temporal behavior of the compressed air station and its components. This requires machine-readable dynamic models. Machine-readable dynamic models of physical systems are typically described by a set of differential equations, which are often nonlinear as well as time- and structural-variant and can be described well with hybrid automata. Even an expert in the field of mathematical modeling of dynamic systems will not find it easy to define the correct set of differential equations ad hoc and derive a machine-readable model when looking into a real compressed air station. It is, thus, impossible for non-experts in the field.

In the case of KAESER KOMPRESSOREN SE, the problem of creating a dynamic model of a compressed air station is solved by providing dynamic models for components of the system in a database and automatically deriving a dynamic model of the compressed air station (i.e., an algorithm generates a dynamic digital twin of a compressed air station based on the manually created static model).

The automated creation of the dynamic model is enabled by dynamic models of the components of the compressed air station stored in a database. These dynamic component models are equipped with standardized interfaces in such a way that they can be connected 1:1 according to the static model of the compressed air station. This principle is shown in Fig. 4.

Thus, a structurally equivalent dynamic model of the compressed air station can be created from the static model. The model is derived from models. The algorithm implementing this process has the task of selecting the correct dynamic models from the database in relation to the use case because different models can be stored for different use cases for the same component. The following aspects have to be considered in the selection process:

- What physical effects are considered?
- What computing effort is required for the evaluation of the model?
- How exactly does the model work in the relevant field of application?
- What number of parameters is required for a realistic evaluation of the model?

5 Simulation-Based Control of Compressed Air Stations

One of the most important applications of a dynamic digital twin of a compressed air station, which is derived according to the process shown in Fig. 3, is the simulation-based control of compressed air stations. In the simulation-based control of compressed air stations, the digital twin is used to examine various variants of control strategies for compressors virtually, thus determining the most advantageous variant and then implementing it in real time. The basic sequence of a control cycle is shown in Fig. 5.

In the first step, the current situation in the compressed air station is captured. On the basis of heuristics, promising control strategies are derived for the current situation, the effects of which are then investigated by simulating the possible future behavior of the compressed air station (application of the dynamic digital twin). By evaluating the simulation results, the most efficient control strategy is selected and finally implemented. This control cycle is carried out regularly (e.g., once per second) for a variety of control strategies (order of magnitude 100), with the period covered by a simulation covering more than 10 minutes (depending on the situation).

Wagner and Frey (2011) provide further details on the functioning of a prototype of a simulation-based control of compressed air stations (as of 2008). Since 2015, a significantly further improved version of the simulation-based control system for compressed air stations is available on the market as a standard product (SIGMA AIR MANAGER 4.0) and has already been installed several thousands of times. The step of deriving the dynamic digital twin takes place in the master control system SIGMA AIR MANAGER 4.0 after providing the static digital twin (PFD,

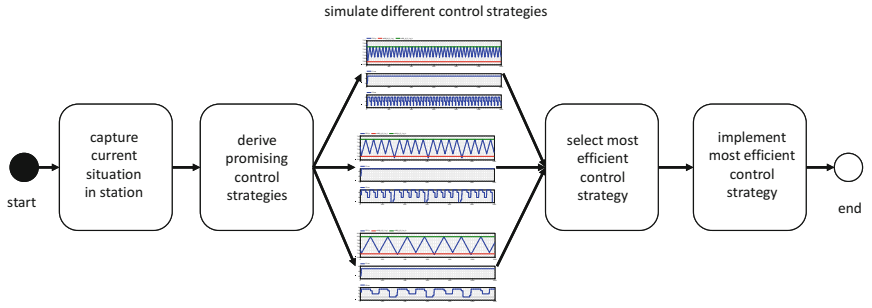

Fig. 5 Expiration of a control cycle in the simulation-based control of compressed air stations. Own illustration

component list, component properties, behavioral models of the components) in a machine-readable form.

6 Simulation-Based Planning of Compressed Air Stations

When planning/designing new and/or changing compressed air stations, dynamic digital twins are used to simulate the behavior of alternative variants for a representative period (typically 7 to 14 days) to obtain a forecast for the expected costs for the investment, operation, and maintenance of each of the variants. By comparing the forecasts, the most cost-effective variant can be determined.

A particular challenge in simulating the behavior of a compressed air station is the consideration of the control processes implemented in the compressors and in the cross-machine controllers. These control processes have a significant influence on the behavior of the compressors and thus on the energy efficiency of the compressed air station. This means that if the control methods are taken into account incorrectly or not at all, the forecasts are subject to vast uncertainty resulting in the selection of a possibly unfavorable variant. KAESER KOMPRESSOREN SE solves this problem in two ways:

- The control procedures contained in the compressors use simplified but still sufficiently accurate models that reflect the essential effects of the control process.
- For the control method included in the master control system, the real control code is integrated into the simulation, not a simplified model.

The structure of the controlled station simulated in this way is shown in Fig. 6.

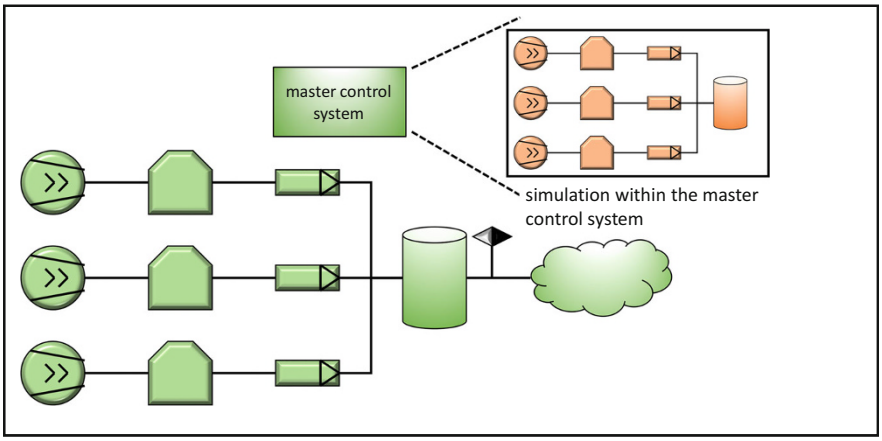

Fig. 6 Structure of the simulation of the controlled station. Own illustration

Since the controlled station has to be simulated for sufficiently precise predictions of the costs, not only a simulation model of the variant of the compressed air station to be tested (shown in green) is used but also a simulation model which is applied in the control process in the cross-machine control (shown in red). The simulation model of the control process is thus embedded in the simulation model of the entire compressed air station.

In order to enable the embedding of the real control method into a simulation that takes place faster than real time, this application was explicitly taken into account in the development of the control method of the cross-machine control.

7 Model-Based Monitoring of Compressed Air Stations

Another application for a dynamic digital twin is the monitoring of components in compressed air stations. This is done by using the dynamic digital twin as an observer/state estimator. Due to the real observed course of measures of the component to be monitored, a parameter estimate for directly non-measurable quantities takes place in the dynamic digital twin, the values of which then give statements about:

- Whether the component is functioning or not.
- What is the possible cause of a component malfunction?

For instance, with the help of a thermal model of a compressor, it is possible to determine which time course temperatures in the oil circuit of a compressor should follow. If the thermal model takes into account the contamination of the oil cooler, it is possible to determine by parameter estimation in the dynamic digital twin whether the contaminated oil cooler is the cause in case the temperature is too high.

8 Summary

The chapter explained that the use of digital twins throughout the life cycle of a compressed air station creates tangible benefits. It is important to note that there is not one digital twin of a compressed air station, but several digital twins that are used in relation to the respective application. In addition, there is not one system in which the digital twin(s) are instantiated or executed. Instead, several digital twins must be instantiated and executed simultaneously to a compressed air station in several systems. This results in the challenge of keeping the many digital twins consistent in the various systems. At KAESER KOMPRESSOREN SE, the problem of consistency was solved by the fact that the structure and technical characteristics of compressed air stations and their components are semi-automatically modeled and managed by non-experts in a central database system. Digital twins of the compressed air station are derived and applied from the information stored in the database system fully automatically and in relation to the use case. Through this

two-step process of creating digital twins, all digital twins are based on the same semi-automatic modeling of the compressed air station, and the problem of consistency does not exist at all or only occurs in a weakened form. If the base model is changed, all derived digital twins can be automatically recreated. Solving this separately is how and when the digital twins are distributed and applied to the systems.

Reference

Wagner, F., & Frey, G. (2011). Simulation-based control of compressed air stations. In *VDI-Reports: Vol. 2143. Conference Volume Automation Congress 2011* (pp. 57–60). Baden-Baden.

Index

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