Fraunhofer IPT

White Paper

Monetizing Data in Networked, Adaptive Production – Succeeding in Data-Driven Ecosystems

Table of contents

An industry in upheaval – How data is transforming the manufacturing industry

Increasing amounts of available data and growing interdependencies within company networks play a significant role in the future of manufacturing companies. Both B2B and B2C markets have undergone drastic changes, driven to a large extent by new technologies and increasing amounts of available data. Many real-world examples underline this development across industries and applications: For example, end-users spent over $400 billion US on public cloud services in 2021 [1] and according to a PwC-study 98% of industrial companies aim to increase efficiency via digital technologies [2].

In the manufacturing industry, massive amounts of data are created along the physical value chain. This data offers significant potential for manufacturing companies to improve productivity [3] and develop new business models [4]. Furthermore, data can improve decision-making, market foresight, and innovation [2].

However, companies face several challenges trying to generate value based on data. To begin with, the identification of potential data-based value is no easy task. The same applies to assessing, capturing, and monetizing this value associated with specific data. Furthermore, companies have become increasingly dependent on others to achieve such potential, for example, providers of integration solutions or digital platforms. Ultimately, companies do not only face the challenge of leveraging data but, on a larger scale, the critical task of strategically positioning themselves within fast-changing, data-driven ecosystems to maintain or improve their competitiveness.

Hence, this work aims to provide insights on these challenges and tasks supported by a study carried out by the Fraunhofer IPT in close collaboration with the International Center for Networked, Adaptive Production (ICNAP) and experiences gathered within industry and research projects.

Data-driven ecosystems and data utility potentials

Value creation increasingly takes place within data-driven ecosystems

In a data-driven world, companies no longer solely rely on a set of little-known, largely independent suppliers of physical goods to create value. Instead, creating value based on data increasingly depends on connected, synergetic players along and around the value chain: Companies operate in data-driven ecosystems. Such ecosystems come with opportunities as well as threats. For example, data exchange with suppliers can improve process efficiency. At the same time, fast-moving competitors with aggressive data-driven business models, such as platform providers, may threaten a company's competitive position. [5, 6]

To stay competitive in the long run, companies must be aware of their environment and capture the opportunities presented by ecosystems. Players along the value chain must develop innovative and integrative solutions to offer new or improved products and services. They must build networks and partnerships beyond their traditional supply chain, increase collaboration, and facilitate data exchange. More fundamentally, companies must recognize the value potential of data across organizational boundaries and understand the ecosystems surrounding them. [7, 8]

During joint workshops, the Fraunhofer IPT together with the ICNAP community, including several industrial partners, identified and characterized different generic roles within data-driven ecosystems in the manufacturing industry. These roles capture certain characteristic features associated with specific contributions to the network a company may provide. Figure 1 depicts the roles closely tied to the (traditional) physical value creation. The Original Equipment Manufacturer (OEM) occupies a central role within each ecosystem. They provide direct value to the customer through the product or service sold or leased and are well-positioned to gather production and field data. Different tier suppliers likewise contribute directly to

the core physical value-adding stages. Providing the necessary input for upstream value creation, they too can accumulate production and field data of their products. Industrial service providers and machine manufacturers enable tier suppliers and OEMs. Service providers can offer digital support, for example, through shopfloor software integration, while machines can be (or already are) equipped with sensors, gathering data needed for optimization.

Beyond the roles closely associated with physical value creation, we can identify system integrators and infrastructure providers (see Figure 2). They provide the physical and non-physical foundation for gathering, processing, and utilizing data. The data analyzer/domain expert and the digital platform provider complete the data-driven ecosystem. Data analyzers offer domain-specific in-depth know-how for the analysis of data and decision support. Digital platforms interconnect machines, products, or companies, creating value through the networks they build. Combined, these roles and their interactions comprise a data-driven ecosystem. Figure 3 depicts the roles and typical interactions in data-driven ecosystems.

Original equipment manufacturer
Direct value creation through product or service sales to end-customer

Tier supplier
Production and sale of parts of downstream value-adding stages

Machine manufacturer
Supply of machines and integrated sensors (potential retrofitting)

Industrial services provider
Support of value creation and deployment of hard- and software

Figure 1: Roles in data-driven ecosystems (I/II)

System integrator
Technical solutions for data integration, pre-processing

Cloud and storage provider
Cyber-physical infrastructure for connectivity and communication

Data analyzer/domain expert
Data preparation and analysis technologies and services

Digital platform provider
Digital interconnection of machines and players

Figure 2: Roles in data-driven ecosystems (II/II)

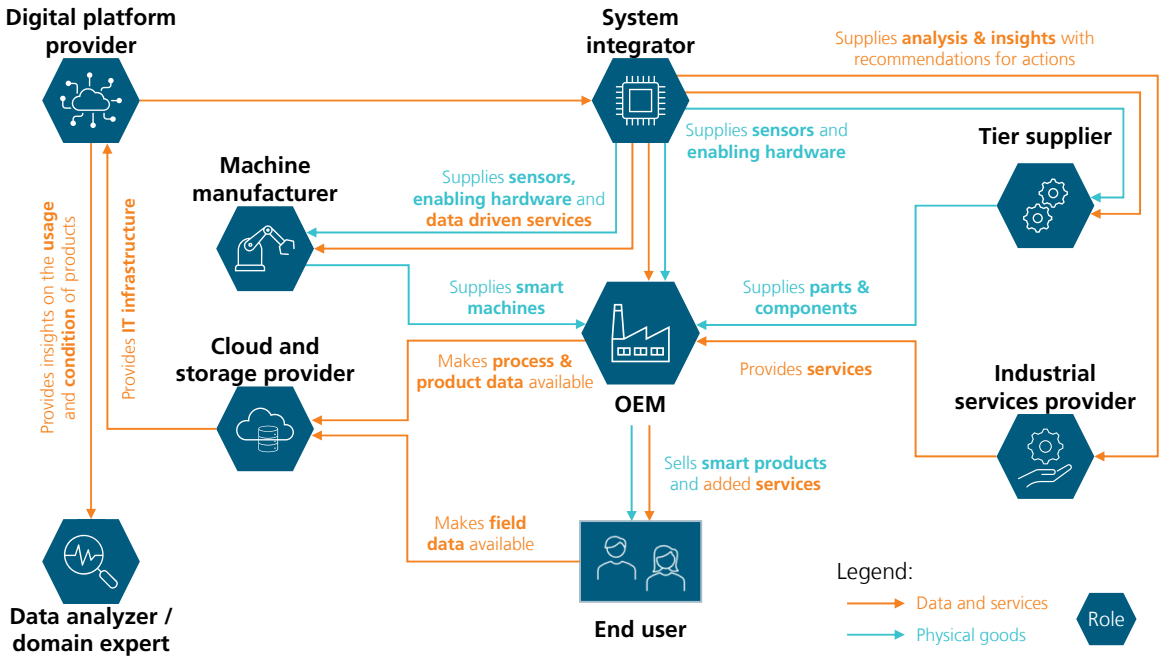

Figure 3: Overview of roles and connections in data-driven ecosystems

Data utility potentials are central to data monetization and strategic positioning

Assessing the value lying behind data and how it may be monetized is challenging for many companies. We introduce the concept of Utility Potentials (UP) in data-driven ecosystems as a tool to systematically analyze data-driven ecosystems and data monetization potential. A UP consists of two constituting components:

- An element or metric that constitutes value
- The potential to improve those elements or metrics by employing data

Such elements or metrics are closely linked to the key goals of an organization. For example, Overall Equipment Effectiveness (OEE) and high product quality frequently represent value to a company. Once the potential is reached, the UP is converted into the value added through the conducted data processing, analysis, and application in combination with the underlying physical value creation. The successful capturing of any UP spans three dimensions (see Figure 4):

- The infrastructure dimension represents the necessary data infrastructure to gather and structure the data. This includes the required sensors, data models, and data management systems.
- Once gathered, data is processed and employed to optimize production efficiency and flexibility, provide services, improve products, and support decision-making in the processing dimension.
- Ultimately, this results in the desired utility as captured in the utility dimension. For example, the improved product quality or reduced machine downtime, contributing to the operational and strategic goals of the company.

In summary, UPs represent the inherent value of data that companies can access through the necessary infrastructure and processes. They are the fundamental driver behind the data-driven ecosystem, creating the incentive to share and exploit data, engage in network collaboration, and seek new strategic positions within the network.

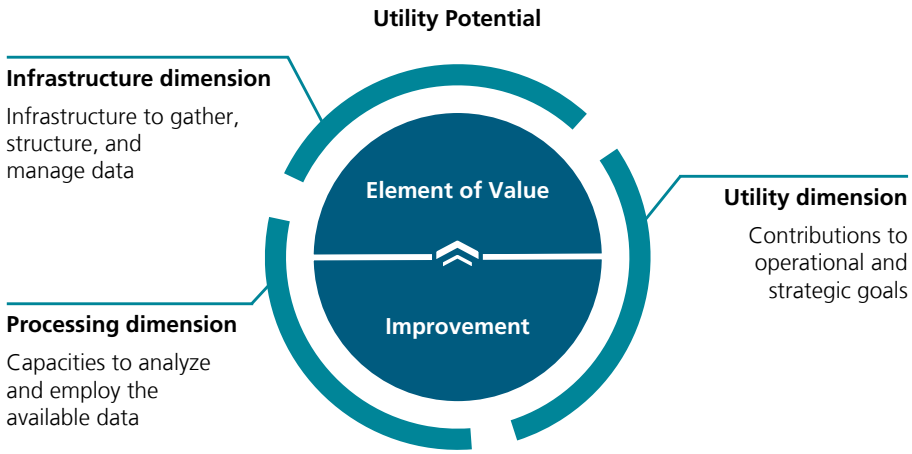

Figure 4: Components and dimensions of utility potential

Five steps to success positions in a data-driven ecosystem

The identification and achievement of strategic success positions in a data-driven ecosystem require companies to thoroughly analyze the status quo, develop and validate compelling hypotheses to move forward, and rigorously execute the chosen path. Based on our experience, we propose five consecutive steps that guide companies in accomplishing these tasks (see Figure 5). The first step aims to identify the most promising UPs within the ecosystem. Within the second step, companies gain an understanding of players, roles, and value creation in their data-driven ecosystem. The third step builds on steps one and two by contrasting the UPs with the contributions towards those potentials for each role. Based on the assessment of ecosystem roles, companies can identify strategic success positions in step four and plan actions to capture them in step five.

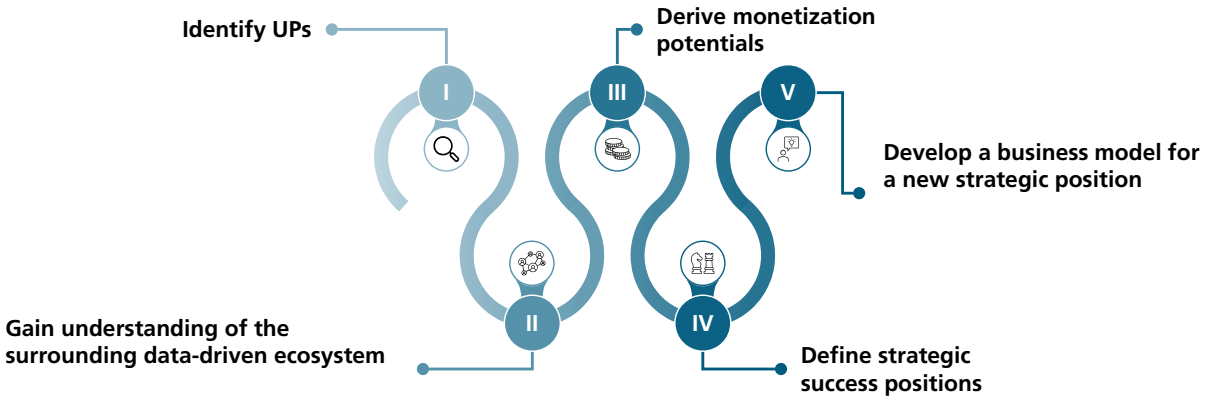

Figure 5: Five steps to success positions in a data-driven ecosystem

I. Identify utility potentials

Data-driven ecosystems involve a vast array of companies, products, services, and data sources and, thus, are complex environments. An initial focus on the UPs of an industry allows companies to reduce this complexity, placing the attention on the centerpiece of any data-driven ecosystem. Later steps can build on this foundation, incrementally enlarging the scope to include all important factors. Identifying UPs involves three tasks: identifying key objectives and their drivers, deriving data-based improvements, and selecting worthwhile UPs.

Identifying key objectives and their drivers:
UPs consist of two elements: First, a subjective utility aspect, and second, the potential to achieve or improve this aspect based on data. Hence, companies must initially answer the question, what constitutes and fundamentally drives value in their industry? Companies can tap several sources to answer this question. These sources include explicit objectives postulated in corporate strategies, key performance indicators (KPIs) commonly employed within the industry, and customer requirements of the target market. The analysis of these sources results in a comprehensive set of industry and company objectives, including clear-cut metrics such as "Return on Capital Employed" (ROCE) or hard-to-quantify objectives such as customer satisfaction.

These generic utility aspects are the core motivation for all activities in the ecosystem. However, directly linking them to data-based improvements may prove difficult. For instance, it can be challenging to immediately recognize the potential benefit of a data set to a company's profitability. To overcome this issue and to facilitate linking utility to data, companies need to identify crucial drivers behind the generic utility aspects. In the case of customer satisfaction, for example, drivers likely include product quality and price.

Deriving potential data-based improvements:
Next follows the identification of potentials to improve the utilities based on data. The aim is not to develop fleshed-out use-cases but to identify broad concepts or ideas on how data might be used in specific instances to contribute to the previously identified drivers. This may include data-based improvements of products, services, or processes, entirely new services, or increased transparency along the supply chain. Companies can choose freely from the plethora of existing creative methods to accomplish this task. However, they need to consider several aspects. First, the scope should not be limited to the company but include customers, suppliers, and other partners. This relates to both utilities and sources of data. Second, potentials beyond the current status quo are to be considered, for example, improvements that the company expects to soon be accessible due to new technology. Also, companies need to explicitly explore value in complementary products and services along the entire product life cycle. Figure 6 displays an illustrative case with an exemplary UP. Striving to increase OEE, improve quality, and reduce lubricant and tooling cost the company identified the opportunity to improve these goals by capturing vibration data.

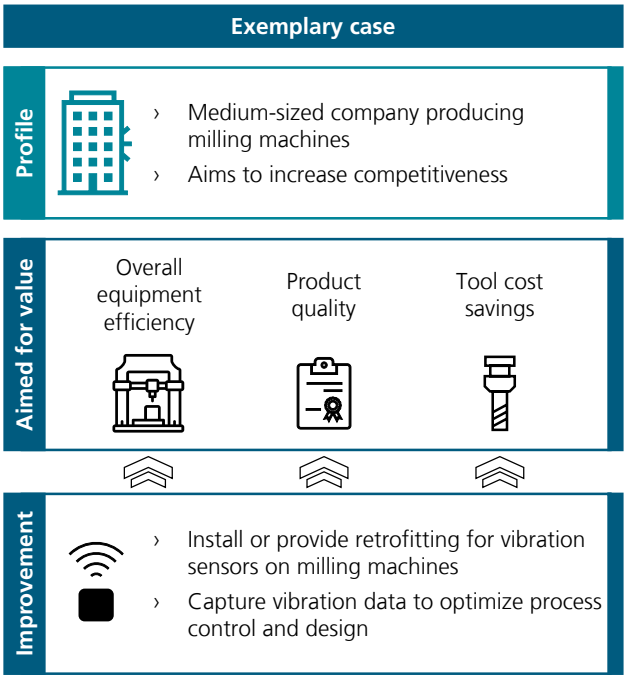

Figure 6: Exemplary case of a UP for a machine producer

Selecting promising UPs:
The task of identifying potential improvements involves no quality gate or threshold to qualify. However, not all UPs are worth the required effort. Therefore, companies should limit their scope to those that appear promising based on the assessment of the attractiveness and feasibility of each UPs. The attractiveness of a UP is determined, among other factors, by the importance of the underlying goal and synergies with other UPs. The UP-feasibility benefits, for instance, from the viability of the technical realization and existing data infrastructures. On the flipside, feasibility may, for example, suffer from a lack of (accessible) data.

Utility Potentials are the fundamental driver behind the data-driven ecosystem, creating the incentive to share and exploit data, engage in network collaboration, and seek new strategic positions within the network.”

II. Gain understanding of the surrounding data-driven ecosystem

Compared to the physical value creation network, the data-driven ecosystem encompasses additional roles such as digital platform providers or system integrators. Furthermore, value creation and competition work differently. New sources and ways of value creation reshape competition (e.g., new entry barriers, substitutes, or competitors) while simultaneously opening avenues for collaboration and partnerships. Accordingly, companies must generate an overview of the players and their roles in the ecosystem, achieve transparency over how value creation takes place, and analyze the competitive environment.

Creating an overview of the players and their roles in the data-driven ecosystem:
Initially, a company needs to identify all players it interacts with within the broader spectrum of the physical value chain and ecosystem. This spectrum includes manufacturing companies, service providers, or any other separate entities participating in the value creation for a focal customer. After having identified all relevant companies, the different basic roles presented in the previous chapter are assigned to the players. We base this assignment on role characterizations (see Figure 7 for an exemplary characterization of a system integrator), primarily on how a player adds physical and digital value in a data-driven ecosystem. Characteristic requirements for a role often represent easy-to-observe indicators. To illustrate, a player that offers technical solutions for data integration plays the role of a system integrator to some degree by default.

Identifying the value streams throughout the data-driven ecosystem:
All players and roles in the data-driven ecosystem interact to create value. One way to capture this interaction is to identify the "value streams" throughout the ecosystem, in this instance, the flow and exchange of physical goods, services, and data among players. Physical goods may be raw materials, parts, and finished products, as well as equipment, hardware, and sensors. Services may include standard industrial services (e.g., engineering, maintenance) and the provision of IT infrastructure or digital platforms. The dataflow encapsulates the exchange of raw data, data analysis, and primarily data-based decision support.

Analyzing the competitive environment:
The interconnection between the physical value chain and the data-driven ecosystem impacts competition in the industry. For example, the impact of digital platforms such as Amazon on the traditional retail business has been far-reaching and substantial. Accordingly, it is paramount for companies to analyze the new competitive landscape in which they find themselves. Companies can structure this analysis along the different roles, ascertaining respective competitive forces and evolutions. For instance, companies need to assess entry barriers related to physical and digital products or services for each role. To illustrate, a machine manufacturer may recognize the potential value in offering system integration hardware for sold machines, thus, entering the respective market from an advantageous position.

Exemplary Role Profile of a System Integrator

Role requirements

- Provide **technical solutions** for the integration of hardware & data
- High **compatibility** and **cooperation** with different manufacturers
- A **uniform output** must be found from several input variables

Characteristic Features

Physical value added

- **Technical implementation** or conversion of production with sensors, components or even machines
- Equipped in advance or retrofitted afterwards

Digital value added

- Provision of new data streams for subsequent processing
- Connecting to existing infrastructure to enable data flow
- Provision of monitoring and alerting
- Initiating new cases for action

Role requirements

- IIoT-hardware integrator
- On site and cloud integrator

Customers

- Industrial service providers
- Machine manufacturer
- OEM

Figure 7: Exemplary role profile - system integrator

Crucial competitive factors in data-driven ecosystems include (primary) access to data and customers, human capital, and (proprietary) technology. Furthermore, companies are well-advised to consider how technological developments impact physical value creation, leading to new role requirements. In an environment driven by technological advances and rapidly changing circumstances (from regulation to consumer behavior), the ability to innovate products and processes represents a vital success factor. In summary, companies face challenging tasks and decisions to identify and capture attractive strategic positions within this dynamic competitive environment.

III. Derive monetization potentials

Where and to which degree UPs exist for a role often will not directly co-align with the available data and capability to capture those UPs. A role that may greatly benefit from a UP may not be able to capture it without contributions in the form of data, services, or physical products from other roles. In this instance, other roles may monetize their contributions, for example, charge for the provision of required data. Following this logic, a UP for one role may translate into monetization potential (MP) for others. This step aims to identify MPs across the ecosystem based on this concept. To that end, we compare the UPs and required contributions for each UP and role. Supplemented by qualitative factors, this yields an overview of MPs. Companies need to conduct this step separately for each UP or group of synergetic UPs. An optional preliminary task is to revisit the first step, as companies may be able to identify additional UPs after having gained an understanding of the ecosystem in the second step.

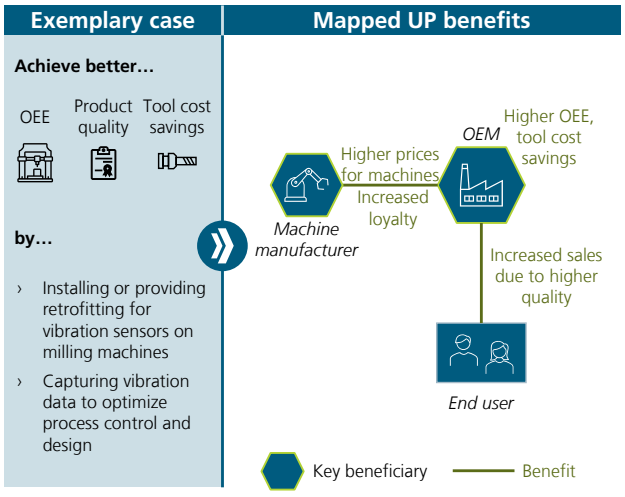

Figure 8: Mapping the UP to the ecosystem in the exemplary case

Mapping individual or combined UPs to the ecosystem:
All gathered UPs or groups of synergetic UPs and their implied benefits are to be separately allocated within the ecosystem. We advise companies to assess the benefit of an UP for each role, i.e., a single UP's benefits throughout the entire ecosystem (see Figure 8). For example, the improvement of OEE, end-product quality, and cost reduction for tools of the exemplary case will likely primarily benefit the OEM. In turn, the OEM may appreciate the enabling technology provided by the machine manufacturer or other roles leading to increased buyer loyalty. Ultimately, this results in an overview of UP-related benefits across the ecosystem for each UP.

Mapping required UP contributions to the ecosystem:
For each UP mapped onto the ecosystem, we can now identify the required flows of data and enabling products or services. For this, companies can draw from the previously identified value streams of the status quo. These will likely not suffice to achieve all UPs. Instead, not yet existing but required flows need to be identified as well. For example, a machine manufacturer may have to develop new process data models accompanied by new sensors provided by the system integrator. Figure 9 depicts an exemplary quantified mapping of contributions for the exemplary case.

Identifying monetization potentials:
For each role, the potential benefits through UPs can be compared with the required contributions. If a role's contributions efforts exceed the benefits it generates through contributing to the UP, players occupying the role may have the leverage to monetize those contributions. In contrast, if the benefits exceed contribution efforts, other players may have an opportunity to monetize their contribution. However, in practice, the asymmetry between UPs and directly linked contribution efforts does not necessarily equate to companies' potential to monetize their contributions.

While for individual UPs, asymmetries might exist, they might cancel each other out in trade-offs between companies. More significantly, competitive factors and market dynamics will enable some roles to consistently capture asymmetrically large shares of the UPs and MPs. For example, an OEM may exercise leverage to obtain data based on negotiation power instead of payment, and a system integrator may create lock-in effects based on proprietary technology. Moreover, when players occupy multiple roles, they may be able to reduce dependencies and internalize synergies.

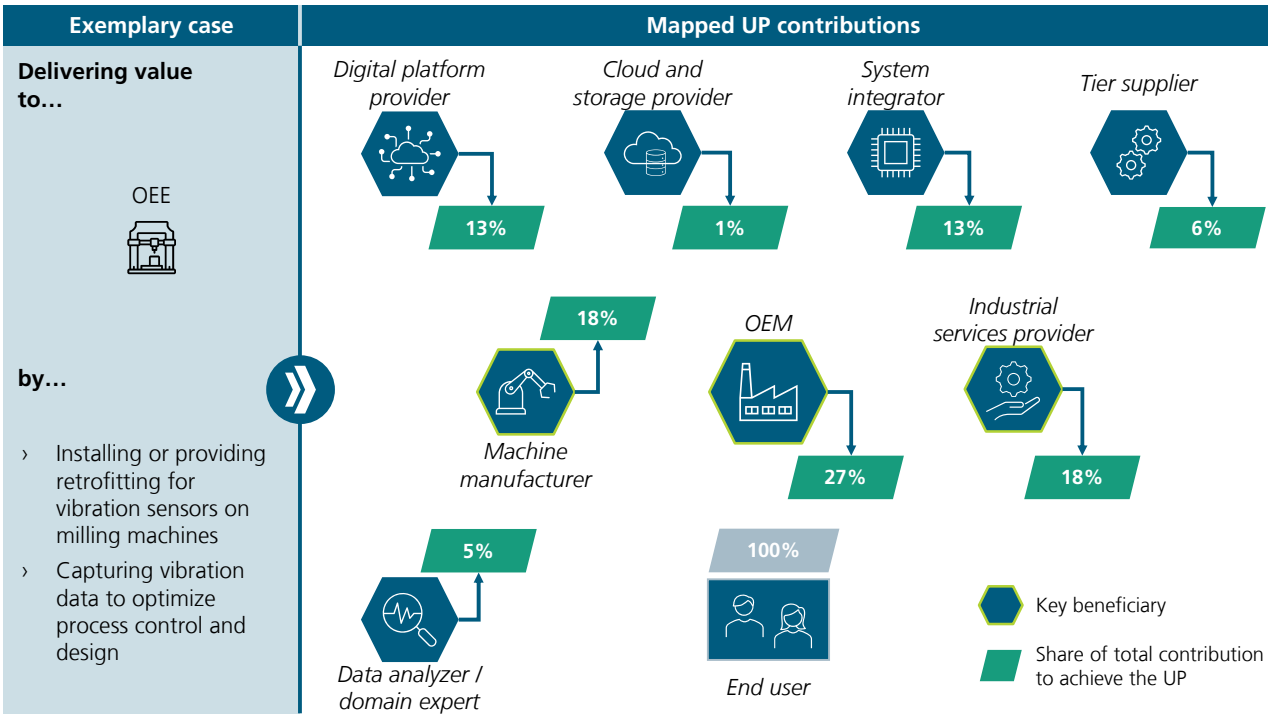

Figure 9: Contributions for the UP of the exemplary case

IV. Define strategic success positions

Defining and understanding strategic success positions within the ecosystem builds the foundation for actions a company may take. Equipped with this understanding, companies can strengthen and protect their position or expand and reposition. For example, companies may be able to anticipate other companies' competitive moves, shift their position towards more attractive ones, or recognize opportunities to realize UPs or MPs.

Assessing attractiveness:
For a holistic approach of strategic positioning, the attractiveness of the ecosystem-underlying business must be considered. In this work, we limit our scope to the data-driven ecosystem. At the core of a position's attractiveness lies its capability to capture asymmetrically large shares of UPs and MPs. To assess this capability, companies need to consider the following factors:

- Accumulated benefits of UPs
- Outgoing contributions to the ecosystem and their MPs
- Dependency on contributions from outside the position
- Bargaining power towards other players

Additionally, traditional factors such as growth potential in buyer groups and competition intensity need to be considered.

Assessing feasibility:
Whether a certain position is feasible predominantly depends on the position the company currently occupies. This includes the existing product portfolio, technological capabilities, experience, and employees. Companies must therefore evaluate the required effort to expand or transition (for example, investments in mergers and acquisitions, new staff, or increased spending on innovation). Furthermore, possible competitive moves of other players are relevant to feasibility. To illustrate, positions that appear most attractive will invite intense competition, and companies may be well-advised to avoid them and instead occupy a niche.

Assessing risk:
The risk associated with a position is a function of uncertainty in attractiveness and feasibility. Uncertainty either originates from within an ecosystem or from external sources. For example, within the ecosystem, intense competition, rapid technological advances, and shifts in bargaining power sharpen a position's uncertainty. From the outside, government policy, societal expectations, and geopolitical concerns may be relevant factors.

Identifying the strategic success positions:
Strategic success positions are characterized by a high attractiveness, a positive assessment of feasibility, and low risk. Companies typically will have to compromise between the three

factors. For example, major shifts towards highly attractive positions may negatively impact feasibility and risk due to heightened competition.

This step should also be conducted from the perspective of other positions to anticipate developments and competitive moves by others. For example, a company might currently occupy an attractive position that other players can easily attempt to enter. Recognizing this in time allows for preemptive actions.

V. Design a business model to fit the new strategic position

After the development of a thorough understanding of the ecosystem and the identification of strategic success positions, companies can choose several actions to benefit. A company may:

- try to take advantage of the identified UPs and MPs in the current state of the ecosystem
- anticipate shifts in the ecosystem and react preemptively
- enter or shift towards new positions

A well-rounded approach to competitive strategy in data-driven ecosystems will include at least the consideration of all three. Within this work, the scope is limited to entering a new strategic position. Specifically, we focus on deriving a business model that fits the strategic position based on the previously gathered ecosystem insights.

Considering boundary conditions before deriving a business model:
The previously identified utility and monetization potentials do not immediately equal revenue or are necessarily easy to achieve. For example, inhibiting factors such as privacy concerns, cannibalization effects, lack of focus, competencies, or resources stand between potential and realization. Therefore, companies should follow a structured approach to ensure both fit within the company and the ecosystem.

Developing a data-driven business model:
At the center of the business model is its value proposition and the potential recipient, echoed by the question: What should we offer to whom? Companies can draw necessary information to answer this question from the previously determined MPs, resulting in a portfolio of data-based offerings towards potential customers in the ecosystem. For example, one element of the business model could be the provision of a data analytics service aimed at improving the ROCE at a customer's production facility. Subsequently, companies must identify new processes, inputs, and collaborations with other players necessary to deliver that portfolio. To continue the example: the services of a digital platform provider may be required to achieve the improvement. Furthermore, in data-driven ecosystems, the offered value frequently depends to a significant degree on collaboration with the customer, as opposed to "simply" handing over a product. Companies must therefore anticipate needs for integration, support, consultation, or even partnerships. In our example, the customer is the player applying the insights generated from the data analysis. Thus, value creation depends on their capabilities to do so.

Having defined the broad business model setting, the companies must choose and execute revenue models for their portfolio of data-driven offerings. This includes the structure and mode of payment. Depending on the underlying offering, companies may, for example, choose pay-per-use, subscription, add-on, pay-for-availability, or revenue sharing as an overarching model, supplemented by dynamic pricing and volume discount mechanisms. To assess customer willingness to pay, companies can draw on estimates of UPs and the contribution the company provides.

Four principles to succeed in the long-run

Concluding, the outlined five steps to monetize data provide guidance in gaining a thorough understanding of data-driven ecosystems and the concept of strategic success positions. Data monetization in manufacturing value creation and positioning within data-driven ecosystems pose a complex and challenging task. Many manufacturing companies try to realize the collection of data with the intention of monetization. Our approach enables companies to fulfill their goals within the broader scope of data-driven ecosystem value creation, including data monetization. In addition to the presented approach, we consider several principles crucial in order to succeed in data-driven ecosystems (see Figure 10).

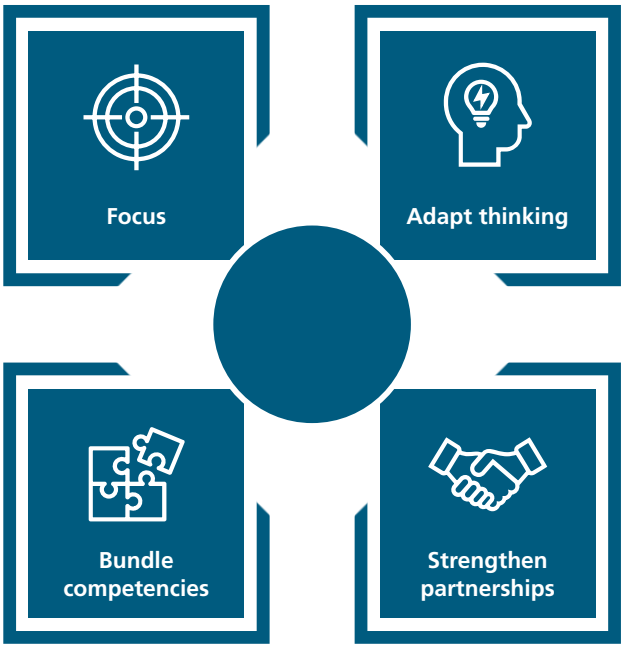

Figure 10: Key principles to succeed in data-driven ecosystems

Focus

Practice shows that manufacturing companies aiming to monetize their data tend to get lost in the weeds, especially considering their history of primarily physical value creation. Therefore, it is crucial that companies don't try to do everything in parallel but instead recognize the best fitting role(s) in the ecosystem and fulfill them well, i.e., focus on the chosen position and associated value-capturing mechanisms. Such focus poses a challenging strategic and operational task, requiring a careful alignment of activities within and beyond the company. It also implies a close fit between market offering, internal competencies, and role(s) in the ecosystem.

Adapt thinking

A second principle to follow is a mindset of forward thinking. The monetization of data can require investments that may not yield rewards immediately. For example, the investment in a solid data infrastructure will seldomly lead to immediate returns but instead enable future projects and value creation. Crucially, a strategic position is not a destination but rather a path of continuous development tuned to the industry and ecosystem. Manufacturing companies must continuously achieve awareness of the fast and impactful shifts in their surroundings, enabling preemptive, well-executed strategic moves and minimizing costly, delayed reactions.

Bundle competencies

Companies striving for the monetization of data need a holistic set of competencies. Crucial competencies can be identified based on the current as well as intended future roles in the ecosystem. As shown, not only digital competencies, but also competencies from physical value creation are important to realize a strategic success position. Therefore, manufacturing companies need to bundle the necessary competencies across the organization. Bundling competencies makes them more accessible, supports a synergetic build-up, and ultimately enables the execution of strategic and operative measures.

Strengthen partnerships

As previously highlighted, many UPs rely on data from more than one source and company. Consequently, companies must engage in cross-organizational collaboration and strengthen their partnerships: Move away from the mindset of (company-specific) silos and try to engage in partnerships that allow to overcome data-related privacy or secrecy concerns, which frequently inhibit data monetization. For example, the investment in mutually beneficial projects often increases the willingness to share data and thereby explore UPs. Furthermore, strong partnerships contribute to innovation and help defend strategic positions within the industry.

Outlook

Recent technological advances, particularly regarding digital infrastructure, present a unique opportunity for companies today to access the potential of their data-driven systems and achieve dominant competitive positions if they move quickly. The topics discussed in this whitepaper remain a core research interest at the Fraunhofer IPT. For example, the 2022 ICNAP study "Pricing Models for Industrial Data" carried out by the Fraunhofer IPT within the ICNAP community investigated the design and mechanisms of different pricing models we discussed in step five. This study delves into the details of how companies can monetize data-driven offerings and offers a systematic approach with guiding questions to focus respective efforts. It also offers an analysis of industry case studies providing insights into potential pricing models and challenges. We remain committed to our efforts to support companies in accessing value within their data-driven ecosystems.

Manufacturing companies must continuously achieve awareness of the fast and impactful shifts in their surroundings, enabling preemptive, well-executed strategic moves and minimizing costly, delayed reactions."

References

[1] Gartner, Inc. (2022). Gartner Forecasts Worldwide Public Cloud End-User Spending to Reach Nearly $500 Billion in 2022.

[2] Geissbauer, R., Schrauf, S., Berttram, P., Cheraghi, F. (2017). Digital Factories 2020: Shaping the future of manufacturing.

[3] Schuh, G., Potente, T., Wesch-Potente, C., Weber, A.R., Prote, J.-P. (2014). Collaboration Mechanisms to Increase Productivity in the Context of Industry 4.0, Procedia CIRP, Vol. 19, 51–56, doi: 10.1016/j.procir.2014.05.016.

[4] Sorescu, A. (2017). Data-Driven Business Model Innovation, Journal of Product Innovation Management, Vol. 34, No. 5, 691–696, doi: 10.1111/jpim.12398.

[5] Otto, B., Mohr, N., Roggendorf, M., Guggenberger, T. (2020). Data sharing in industrial ecosystems: Driving value across entire production lines.

[6] Lis, B.O.D., Jürjens, J., Cirullies, J., Opriel, S., Howar, F., Meister, S., Spiekermann, M., Pettenpohl, H., Möller, F. (2019). Data Ecosystems: Conceptual Foundations, Constituents and Recommendations for Action.

[7] Pidun, U., Reeves, M., Zoletnik, B. (2022). Are You Ready to Become an Ecosystem Player?

[8] Abdulla, A., Janiszewska-Kiewra, E., Podlesny, J. (2021). Data ecosystems made simple.

Authors

Prof. Dr.-Ing. Dipl.-Wirt.-Ing. Günther Schuh
Member of the board of directors of Fraunhofer IPT and chair holder of the chair of Production Engineering at the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University

Bastian Studerus, M. Sc.
Group Manager in Technology Management

Bastian Bürklin, M. Sc.
Research Fellow in Technology Management

Dr.-Ing. Andreas Zeller
Director Application Engineering, EPoS Technologies SA, Villaz-St-Pierre. Switzerland, and Advisor for Industrial Start-ups and Technology Management

Contact

Dr.-Ing. Marc Patzwald
Technology Management
Phone +49 241 8904-159
marc.patzwald@ipt.fraunhofer.de

Fraunhofer Institute for
Production Technology IPT
Steinbachstrasse 17
52074 Aachen
Germany
www.ipt.fraunhofer.de

DOI: 10.24406/publica-400