

IMPULS



Production as a Service: Promoting Growth through Asset Sharing

Stiftung für den Maschinenbau,
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— Study

Production as a Service: Promoting Growth through Asset Sharing

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Why You Should Read This Study

Geopolitical risks, supply chain disruptions, climate change, and labor shortages are forcing producers to ramp up capital expenditures to invest in local factories, new technologies, and higher degrees of automation. As they seek ways to minimize capex and to reduce risk from a recession, producers can consider “Production as a Service” (PaaS), with many offerings emerging in the market.

However, many Asset Users and Asset Producers are struggling to fully grasp the opportunities and challenges associated with PaaS models. This study sought elaborate on the opportunities and challenges of these models. The authors combine practical experience from working with market participants as well as a scientific perspective from research at WHU – Otto Beisheim School of Management. The input for the content has been further enriched by:

- Structured interviews with various industry representatives (see next page);
- Financial modeling to quantify the impact of PaaS on the financial statements of Asset Users and Asset Producers; and
- Market research.

We focused specifically on the field of mechanical and plant engineering, with particular attention to the roles of Asset Producer and Asset User. This is accompanied by looking at the additional players in a PaaS setting – the Third-party Investor and the Asset Operator which may also be performed by an Asset Producer or Asset User. However, because the concept of PaaS is relatively uncommon, not all examples could be sourced from this industry.

The study finds that PaaS can address current market challenges. In particular, PaaS enables Asset Users to regionalize production by sharing assets with other users thus profiting from economies of scale. On the other hand, Asset Producers can add value by continuously engaging throughout the lifetime of the asset because they have the best understanding of their asset. They can offer pay-per-use financing solutions and boost their returns by participating in financing cash flows of the asset. Furthermore, pay-per-use financing and sharing models allow Asset Producers to access new markets, such as Asset Users who could not fully utilize assets by themselves or lack financial resources for funding. However, when offering PaaS models with pay-per-use features, Asset Producers face scalability issues due to cash flow gaps, balance sheet extension, and risk exposure.

To mitigate financial challenges, Asset Producers need to partner with Third-Party Investors to successfully scale PaaS. The bidirectional relationship of an Asset Producer and an Asset User in conventional one-time sale (OTS) models is replaced with a rectangular relationship involving Asset Users, Asset Producers, Third-Party Investors, and Operators.

The first Third-Party Investors have entered this early-stage market by offering financing services for pay-per-use models. However, only a few of these pioneers have taken actual usage risks. The key success factor when scaling as-a-service models is determining how to allocate the risks to the best owner.

By reading this study, interested parties will become better informed about the opportunities and challenges of PaaS and see specific recommendations for action. Many studies have already discussed as-a-service models in production. This study provides a more in-depth examination of many open questions that have not been answered in the literature. As the key enabler for an improved asset utilization, the sharing of manufacturing assets is evaluated in detail in **Chapter 1**. In the following, the study is structured along the four major roles and elaborates on the guiding questions:

Asset User (Chapter 2):

- How can PaaS help to regionalize production?
- What is the financial impact of PaaS models?

Asset Producer (Chapter 3):

- What is the financial impact of PaaS models?
- How does PaaS change the organizational model?

Third-Party Investor (Chapter 4):

- What is the risk-return profile of PaaS models?
- What is the state of the market for the financing of PaaS?

Asset Operator (Chapter 5):

- Who operates the asset in a PaaS model?

In **Chapter 6**, the study ends with a look ahead and concrete application recommendations for machinery and plant manufacturers.

We would like to thank the following executives for participating in the study by taking time to attend structured interviews covering their perspective on PaaS:

- **Hendrik Dödt**, Global Key Account Manager, KUKA Systems GmbH
- **Ralf Goldbrunner**, Member of the Board Operations, KRONES AG
- **Gottfried Nuber**, Head of Corporate Production, KRONES AG
- **Siegfried Ölinger**, Head of Business & Digitalization, ENGEL Austria GmbH
- **Manfred Peter**, Lead Treasury, Gebr. Heller Maschinenfabrik GmbH
- **Andreas Pott**, Senior Director Automation/Digitalization, GEA Group
- **Sven Rösel**, Vice President Sales Automotive, Schuler Pressen GmbH

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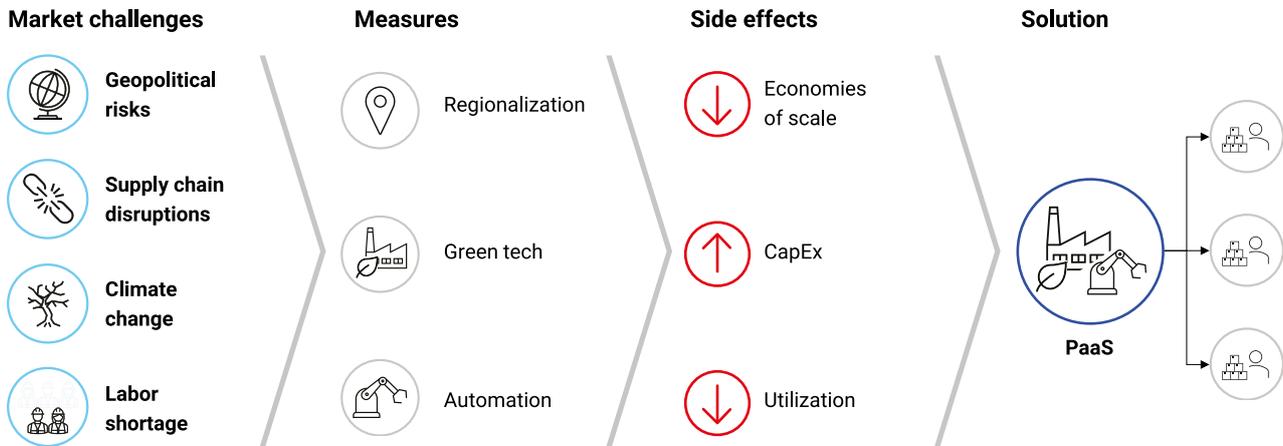
Asset Sharing – The Key Enabler of PaaS

The Key Takeaways

- In PaaS, the linear relationship between the Asset Producer and Asset User is disrupted as an investor and potentially an operator are required.
- Asset sharing between multiple Asset Users increases the utilization of production equipment and thereby increases the chances for external investors.
- Sharing does come in various shapes pending on the company size, intellectual property (IP) requirements, and the flexibility of the underlying technology.
- Challenges of sharing must be understood and addressed by learning from other industries (e.g., logistics) and applying existing technologies.

Exhibit 1:

PaaS as possible solution to address current challenges



To set the stage for delving into our study’s findings, we first lay out the basic benefits and principles of PaaS.

PaaS can address current challenges

Producers are currently facing four main challenges (Exhibit 1).

Two of these challenges were created or exacerbated by the COVID-19 pandemic: geopolitical risks and supply chain disruptions. The pandemic has revealed the EU market’s excessive reliance on Chinese manufacturing and extended global supply chains. But not only supplies are less predictable and therefore more fragile than in the past. The same applies for demand as the heavy dependence on the US and China as sales markets and a possible decoupling of these could hamper future sales. Regionalized manufacturing is gaining prominence as an effective way to reduce dependencies and thereby become more resilient against any decoupling effects. However, regionalization requires high capex investments, causes lower scale effects, and creates the risk of low utilization.

In the interviews conducted for this study, industry representatives also cited the dynamic development of global regions as an additional factor that exacerbates planning difficulties for manufacturers.

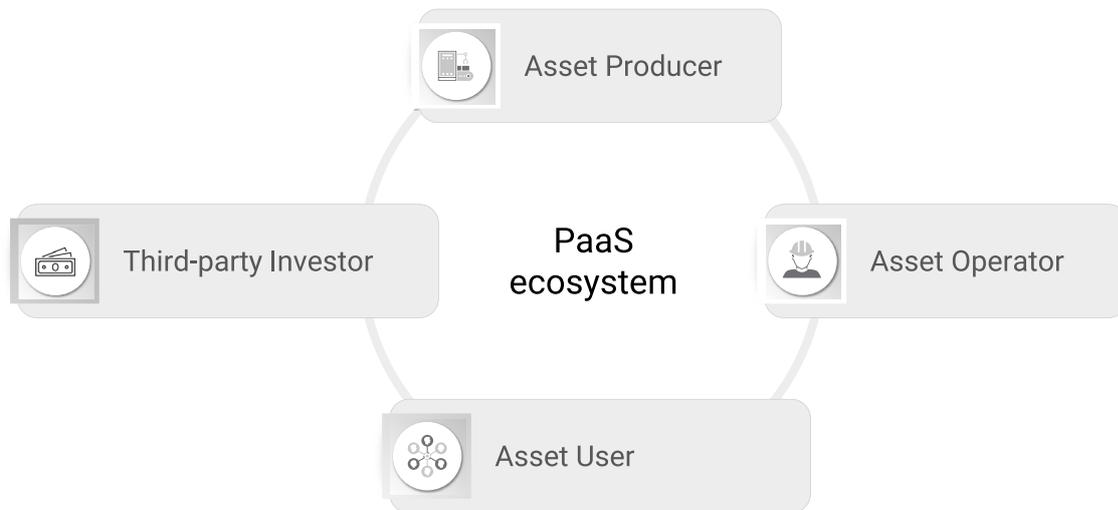
The other two challenges – climate change and labor shortages – reflect broader global trends. Climate change has been a challenge for several years but is gaining significant relevance as its consequences become more noticeable. Policymakers are accelerating the shift towards more sustainable production and products, as evidenced by the recent ban on internal combustion engine (ICE) cars in the EU from 2035 onward. The private sector is also responding to the climate challenge – such as by investing in green technology (for example, more efficient and environmentally friendly machines and factories and the use of recycled materials).

To address labor shortages, many companies are turning to automation. Automation has been implemented in the manufacturing industry for decades. However, since the initial development of the Industry 4.0 concept in 2011, automation capabilities have expanded. This enlargement of capabilities makes automation a key tool to address labor shortages in mature job markets and enables regionalized production.

It is important to note that – like green technology – regionalization and automation solutions also force companies to incur higher capex. The combination of these three factors may result in expenses that are too high for some companies.

PaaS has emerged as a solution to the impacts of today’s market challenges. In a PaaS setting, a highly flexible factory is funded by external parties and shared by multiple users. Sharing distributes capex

Exhibit 2:
Four main roles in a PaaS ecosystem



among users while ensuring higher scale effects and utilization, as multiple companies manufacture in a single location. This also differentiates PaaS significantly from well-known third-party operator models.

The four main roles in PaaS

There are four main roles in a PaaS ecosystem: Asset User, Asset Producer, Third-Party Investor, and Operator as shown in Exhibit 2 (for a detailed description of these roles, see the BCG study “Boosting Resilience With Production as a Service”.) It is important to note that the same company can take multiple roles in this ecosystem – for example, an Asset Producer or an Asset User could act as an Operator or even an Investor.

The first Asset Producers to offer PaaS have done so at the level of individual equipment. However, PaaS is still in the early stages: Based on a recent survey (discussed in the above-referenced BCG study), 15 percent of Asset Producers have a successful PaaS offering, 10 percent have tried but failed, 43 percent plan an offering, and 31 percent are not planning one. This is corroborated by the managers we interviewed who have encountered as-a-service business models. However, only a select few companies have managed to transform theoretical discussions into practical use cases or offerings. Leaders with offerings in the market have cited liquidity and efficiency gains as the primary incentives for Asset Users.

Sharing business models are defined by three dimensions

When considering equipment at the process or factory level, issues of financing and utilization emerge as significant concerns. Thus, a critical aspect to consider when exploring PaaS models is the role of sharing as a means to boost the utilization of asset-intensive production.

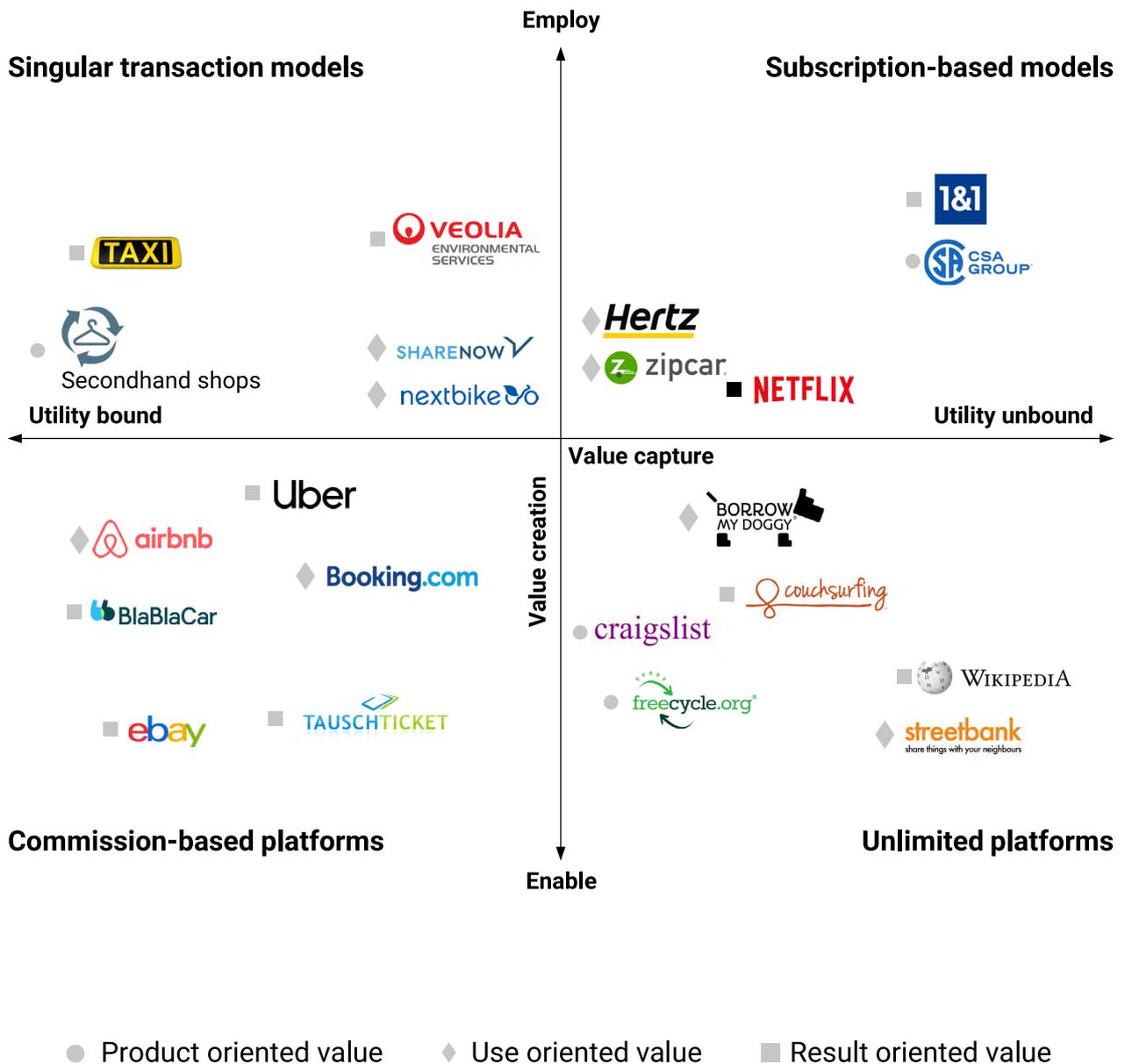
In general, sharing businesses are structured around three dimensions:

- **Value creation** refers to a company’s ability to create value or facilitate its creation. When the value is generated within the company and offered to the buyer, it is considered employed. When the value is created externally, the company’s role is to act as an intermediary between the value creator and the buyer, which is considered enabled.
- **Value capture** pertains to a company’s revenue streams. Bounded value capture occurs when revenue streams are tied to the use or purchase of a product. In contrast, unbounded revenue streams are subscription models in which unlimited use is granted for a fee.
- **Value proposition** is the offering that a company makes to the buyer. In product-oriented propositions, the offering is centered on the sale of a product. In use-oriented propositions, the offering

focuses on the use of a product, with the company retaining ownership and merely granting the buyer the right of use. In result-oriented propositions, the buyer does not purchase a specific product but rather a result, without specifying how the result should be achieved.

Sharing business models have existed for some time, but in recent years the market has grown rapidly due to an increase in the products and services that can be shared. Sharing companies typically organize around four business models in line with the three dimensions cited above (Exhibit 3):

Exhibit 3:
Four types of business models in the sharing economy



Source: M. Ritter, H. Schanz, 2019, The sharing economy: A comprehensive business model framework, Journal of Cleaner Production

Singular transaction models: In these models, businesses are utility bounded. Companies employ workers (insourcing) or instruct other companies (outsourcing) to create and deliver value. For example, a taxi driver delivers value by driving the user from point A to point B and is paid for it.

Subscription-based models: These companies employ their utility-unbounded products. Contracts are provided to ensure a certain amount or unlimited use of a product or service within a given time span. There has been a recent increase in this type of business, as many subscription platforms, such as Netflix and Spotify, have gained major relevance in recent years. Additionally, some subscription models in the manufacturing industry, like CARBON 3D, have emerged. However, subscription models in the manufacturing industry do not necessarily entail sharing.

Commission-based platforms: This type of business model is typical for intermediaries. The company does not have a product itself but connects buyers and producers through its platform, meaning that value creation is externalized. Such companies employ only a few workers. These platforms have also benefited from rapid growth due to increasing digitalization and connectivity. For example, Airbnb has become one of the most popular alternatives for finding holiday accommodations without owning any properties itself.

Unlimited platforms: Revenue streams for these companies are captured from indirect sources, such as advertising. Their functioning is similar to commission-based platforms, as they connect users and producers, but there is no transaction between them. As a result, they need indirect revenue streams. For instance, Wikipedia facilitates knowledge sharing without any transaction, and the site can maintain its operations thanks to donations.

What does sharing mean in a production context?

In a production context, sharing refers to the utilization of production assets by multiple users, with a single Operator overseeing the assets.

Considering this definition, if multiple users share facilities but manufacture their products with proprietary assets (or lines), this scenario would not be considered sharing, because the manufacturing assets are specific to just one user.

It is also important to note that we consider sharing to occur when assets remain fixed in one location and are not transported to the user's location (for example, equipment rental). If assets are transported to the user's location, it would prevent other users from utilizing the assets. Consequently, simultaneous use of the assets by multiple users – that is, sharing – would not occur.

Five major archetypes of sharing in a production context

Sharing has occurred in the manufacturing industry for decades through traditional outsourcing or sharing of production facilities within a group or a joint venture. However, even though these models meet all the requirements to be considered sharing, society has not defined them that way. Sharing outside the group or outside the joint venture represents more recent sharing archetypes.

Five sharing archetypes differ along two dimensions: asset ownership and asset location (Exhibit 4).

In most cases, the assets belong to the producer or the group/joint venture. It is only outsourcing if the assets belong to a third party (the outsourcing company). In all cases, investors (whether of equity or debt) can be leveraged to obtain the required funding for the acquisition of assets. Regarding location, when sharing inside or outside the group, on-site assets are used to maximize the utilization of group facilities. This is also the case when sharing within a joint venture, although there is an option to have an off-site location shared by the members. In outsourcing or sharing outside the joint venture, the assets are always off-site. In outsourcing, this is the case because the outsourcing company has the expertise and assets to perform the manufacturing processes. In sharing assets outside the joint venture, it is necessary to create an off-site location to separate the joint venture activities from each member's operations. This facilitates IP protection, which is essential for external companies that want to access the joint venture's facilities.

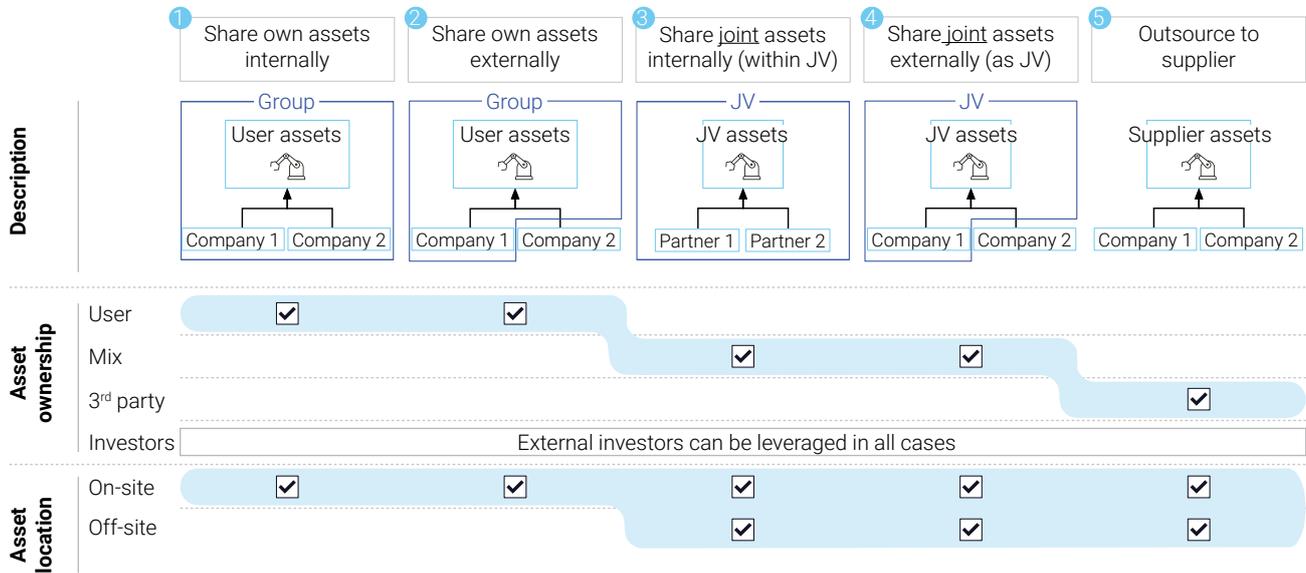
Numerous examples exist across sharing archetypes in the manufacturing industry:

— **Sharing inside the group:** Bosch and Siemens premium washing machines are manufactured in the same factory in Nauen, Germany. Although the assembly line for each brand is separate, they share the production line of the drum.

Exhibit 4:

Five major archetypes of sharing in production context

Sharing option space from user perspective (non-exhaustive)



- **Sharing assets outside the group:** The yacht company Al Seer Marine shares its 3D printing machine with other companies to achieve better utilization.
- **Sharing inside a joint venture:** Volkswagen and Ford built a factory together, forming a joint venture called Autoeuropa to manufacture the Volkswagen Sharan, Seat Alhambra, and Ford Galaxy. Later, Ford would leave the joint venture, selling its participation to Volkswagen.
- **Sharing outside the joint venture:** The Smart Press Shop is a joint venture between Porsche and Schuler. Both companies built a press shop in Germany that is flexible enough to manufacture body parts for different OEMs.
- **Outsourcing:** Among the many examples is Stadler, which manufactures trains for various train operators in Germany and Austria at its facilities in Valencia.

Deep dive: Sharing expands from products to production

We have seen that sharing has been present in the manufacturing industry for some time. Traditionally, companies have shared products. Today, they are sharing production:

- **Product sharing:** Even though multiple companies used the same facilities to manufacture their products, the products of the different companies were mostly the same. For example, the VW Sharan, SEAT Alhambra, and Ford Galaxy shared the same platform.
- **Production sharing:** Now, technology has evolved sufficiently to enable sharing of complex production systems. These systems are flexible enough to manufacture different products with the same assets. This is the case with the Smart Press Shop, which can manufacture different body parts for various OEMs.

Not only is the technical complexity higher in production sharing, but so are the IP protection requirements. Sharing outside the group or outside the joint venture means that companies that could be rivals might share the same production facilities. Therefore, confidential information must be carefully handled and protected.

Deep dive: Production sharing can range from a single process to the complete production line or system

Both the Smart Press Shop and Al Seer Marine are examples of production sharing. However, there are clear differences between them.

— The Smart Press Shop makes sharing its core business. The entirety of the manufacturing process is designed from the beginning to manufacture different products with minimal setup times – that is, to share production with multiple users.

— Al Seer Marine, by contrast, views sharing as an opportunity to increase the utilization of its 3D printer. Its core business is manufacturing of its own boats, but it utilizes sharing as a complementary business to increase its profitability.

It is important to note that in the Smart Press Shop, the entirety of the production process is shared, and all the assets are designed for flexibility. For Al Seer Marine, only one part of the process (the 3D printer) is shared and only the technology it uses for one of its production steps is flexible enough to manufacture different products.

Singular transaction models dominate the production asset-sharing market

Singular transaction models are the most used models for sharing in production. The value capture is bound to the manufactured product, and there is usually no intermediary – placing them in an enable business model category. However, sharing platforms operate as commission-based platforms – they do not own the assets for manufacturing but connect buyers and sellers.

We can conclude that for complex products with extensive concatenations of processes during manufacturing, singular transaction models are the standard. However, for simpler products requiring single-step or just a few steps for production, the commission-based platform is the preferred business model.

Operational challenges of sharing

Although sharing has emerged as a solution for current market challenges, it also introduces new challenges that must be addressed for successful implementation. The sharing challenges coincide with the challenges of implementing PaaS.

The BCG survey cited above indicates that companies view technical challenges as the primary pain point for PaaS (Exhibit 5). This is also the case with sharing, as the system must be flexible enough to manufacture different products.

Exhibit 5:

Operational challenges of sharing

The main challenges of sharing coincide with some of the most relevant challenges of Production as a Service

Technical challenges



Finding the right users to share production infrastructure



Intellectual property protection



Commercial process (pricing, billing, payment)



Control of users with regard to capacity



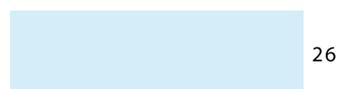
Liability challenges



Financing challenges



Regulatory hurdles



Source: D. Küpper, K. Kuhlmann, A. Corey, M. Saunders, A. Huchzemeier, P. Hypko, J. Nordemann, 2022, Boosting Resilience with Production as a Service, Boston Consulting Group Study, Factory of the Future surveyNote: Survey question: "What do you see as main challenges to using production as a service?" (respondents were asked to select their top three challenges)

Finding the right users is another concern, as the type of sharing may attract different users interested in participating in production. Depending on the production type, it might be necessary to make capacity reservations to ensure optimal utilization of assets.

As mentioned, IP protection is a crucial aspect, as competitors may share the same production system. The commercial process (billing and pricing) should also be considered, as costs must be shared fairly. The allocation of fixed costs can be particularly challenging.

Finally, user control over capacity must be established, although the specific approach depends on the type of production system. In some cases, on-demand manufacturing might be possible, while in others, long-term commitments might be necessary.

We elaborate on the challenges below:

Challenge #1: Using technology to manage complexity

Digitalization is crucial in addressing the production-sharing challenges of high production flexibility. Fully integrating digitalization into the production process, including managing information flows between partners, ensures a flexible, secure, and efficient operation. Ultimately, manufacturers need to determine how to facilitate fast and flawless changeover processes. As described earlier, the complexity of this task depends heavily on the production technology and degree of standardization.

Challenge #2: Finding the right users

The right users for production sharing depend on whether the entire production process or just a part of it is being shared. Sharing a complete production process often involves users from the same industry, while partial sharing allows for greater flexibility and the participation of users from different industries.

Challenge #3: Protecting IP

The sharing of a production facility by multiple manufacturers necessitates stringent standards for the treatment of production data. For example, it is crucial that manufacturers do not have access to information regarding the number of parts produced by co-tenants. Thus, a PaaS environment demands an

IT system with the highest IP standards. Additionally, agreements similar to those used by contract manufacturers must be considered.

Challenge #4: Allocating costs

To address cost allocation, it is valuable to distinguish between brownfield and greenfield scenarios.

— **In brownfield scenarios**, initial investments for machinery and facilities are already recovered or at least partially covered. Consequently, mainly variable costs, such as energy, material, and labor, must be allocated. Allocating variable costs is straightforward since they are directly related to machine utilization, which can be easily tracked.

— **In greenfield scenarios**, initial investments have not yet been amortized. Thus, in addition to variable costs, fixed costs must be allocated. Allocating fixed costs in shared productions is more difficult, as there is no direct linkage between utilization and fixed costs. This has resulted in the use of various methods to address this issue.

Different methods to allocate fixed costs

Three methods have emerged as possible solutions for fixed cost allocation:

— Distributing fixed costs proportionally to the produced volume – meaning that the fixed costs per part would be equal for every user, based on the total number of parts manufactured.

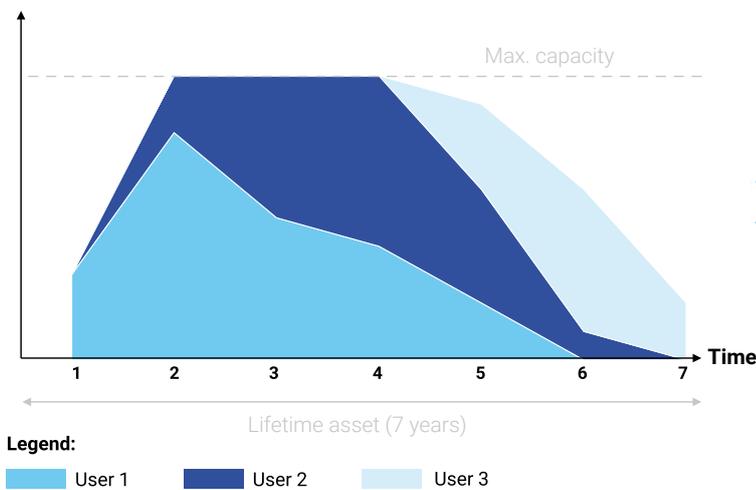
— Allocating fixed costs proportionally to the number of users – meaning that fixed costs are distributed equally among users, independent of the manufactured volume.

— Allocating fixed costs in proportion to the machine hours used – making the fixed costs per machine hour equal for every user.

The simplified scenario shown in Exhibit 6 illustrates how fixed costs can be allocated in a production system with three users producing different volumes. To examine the most challenging scenario, we have considered that the three users have products with varying complexity, requiring different machine times per part.

Exhibit 6:
Different methods to allocate shared fixed costs

Typical load (automotive industry)
Utilization



Methods for fixed cost allocation in shared setup
(Non-exhaustive)

- 1 **Proportional to volume** $\gg \frac{\text{Total fixed costs (period)}}{\text{Total volume (period)}}$
- 2 **Proportional to users** $\gg \frac{\text{Total fixed costs (period)}}{\text{Total number of users (period)}}$
- 3 **Proportional to machine hours** $\gg \frac{\text{Total fixed costs (period)}}{\text{Total machine hours (period)}}$

Fixed costs per part differ depending on the methods used

Exhibit 7 shows that fixed costs per part depend not only on the chosen method but also on the considered period. Theoretically, the price can be calculated for a day, week, month, year, or entire lifetime, depending on the production system and user needs. For simplicity,

we have compared just two time periods: a lifetime and a year. Choosing the lifetime as the reference period results in a fixed price per part for each user throughout the entire utilization of the production system; however, it will be difficult for some users to provide forecasts for such long periods. Selecting a year as the considered period causes the fixed costs per part to vary from year to year. This approach may yield more precise and reliable forecasts from users.

Exhibit 7:
Fixed cost per part vary highly on methods used

Method	Calculation	Description	Fixed cost per part ¹ Period = lifetime (7 years)	Fixed cost per part ¹ Period = 1 year
Proportional to volume	$\frac{\text{Total fixed costs (period)}}{\text{Total volume (period)}}$	All users will pay the same price per manufactured part during the accorded period		
Proportional to users	$\frac{\text{Total fixed costs (period)}}{\text{Total number of users (period)}}$	Users will pay different prices per part depending on their production during the accorded period		
Proportional to machine hours	$\frac{\text{Total fixed costs (period)}}{\text{Total machine hours (period)}}$	Users will pay different prices per part depending on their machine hours during the accorded period		

Legend: User 1 (light blue), User 2 (dark blue), User 3 (lightest blue)

Note: ¹ Exemplary values based on model calculation

Each method finds use in different scenarios

When analyzing the methods, it is important to note that the proportional-to-volume method is only valid when all products manufactured are very similar – that is, they require the same machine time. Additionally, when all products require the same machine time, this method can lead to the free riding challenge. Free riding occurs when users have different production volumes; in this scenario, smaller users would pay a relatively small portion of the total fixed costs. This can encourage small users to participate in production but may put more strain on larger users who bear most of the fixed costs. As a result, the proportional-to-volume method is best applied when production volumes and products are similar among users.

The proportional-to-machine-hours method is a natural evolution of the proportional-to-volume method. This approach accounts for product complexity, enabling a fairer distribution of shared costs when products require different processing times. However, this method also encounters the free-riding issue, benefiting small users while reducing sharing advantages for larger users. Consequently, this method is suitable when products are different, and all users have similar machine utilization.

Last, the proportional-to-users method is an attractive option for large users, as fixed costs are shared equally among users regardless of production. This can, however, result in excessive strain for small producers who will pay high fixed costs relative to their production. This method is best employed when machine utilization is similar among users.

A modified proportional-to-machine-hours method is a potential solution that compensates for unfair cost distribution when production volumes or machine utilization greatly differ. This approach considers the maximum capacity available and avoids free riding while ensuring a fairer fixed cost allocation for all users, even when machine utilization varies significantly.

Before exploring capacity management challenges, it is important to note that real sharing scenarios are not as static as those depicted in Exhibit 6. Furthermore, research from the field of logistics has demonstrated that the most efficient way to handle fixed costs is to not engage on them after production starts and to allow users to sign long-term contracts.¹

To maximize the economic benefits of shared assets, it is advisable to establish a reservation fee to

account for fixed costs (ensuring the availability of capacity when needed) and an execution fee to account for variable costs (preventing potential underpricing by external parties). In this context, it is also noteworthy that significant variation in fixed costs is a strong deterrent for Asset Users and should thus be avoided.²

The ultimate form of asset sharing, with further efficiency gains for both the Asset User and the Asset Producer, involves the application of blockchain-enabled trading when demand is known to users. In such scenarios, some users may choose to forego the use of their reserved capacity when the price of the end-product varies significantly.³

¹ R. Franklin, S. Spinler, 2011, *International Commerce Review*, Shared Warehouses - Sharing Risks and Increasing Eco-efficiency; and A.V. Iyer, A. Jain, 2003, *Management Science*, The Logistics Impact of a Mixture of Order-Streams in a Manufacturer-Retailer System.

² S. Spinler, A. Huchzermeier, 2006, *European Journal of Operational Research*, The valuation of options on capacity with cost and demand uncertainty.

³ K. Wendt, D. Hellwig, V. Babich, A. Huchzermeier, 2023, Georgetown McDonough School of Business Research Paper, DISAS-TER: Blockchain-Enabled Token Trading Game for Supply Chain Management.

Challenge #5: Managing capacity

The approach to capacity management differs based on whether users provide planned volumes or request on-demand manufacturing. The primary distinctions between these two methods are found in five areas:

- **Information.** With planned volumes, users provide volume forecasts that may vary upon confirming production. In contrast, on-demand manufacturing involves users requesting a specific number of parts as soon as possible.
- **Volumes.** Planned volumes typically pertain to mid-to-large production volumes, whereas on-demand manufacturing is generally associated with smaller production volumes.
- **Lead times.** Lead times for planned volumes tend to span weeks or months due to the larger production volumes, while on-demand manufacturing often has lead times as short as days, given the smaller production volumes.

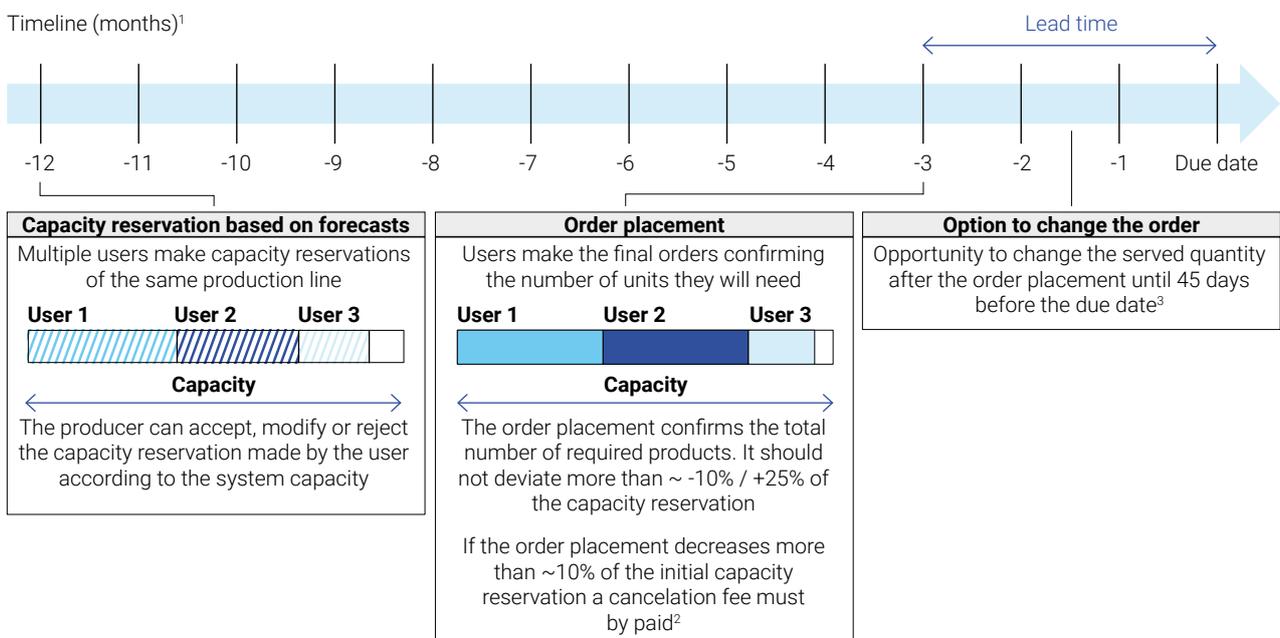
- **Duration.** In the planned volumes scenario, there is a constant flow of information between the Asset User and Operator, with continuous updates on volume forecasts. The entry or exit of users is usually known in advance. However, with on-demand manufacturing, one-time orders are common, and users change frequently.
- **Planning.** Planning is feasible for planned volumes because forecasts are provided. But this is not the case in on-demand manufacturing, where no forecasts are given – in this situation, only scheduling is possible.

We can conclude that the most significant difference concerning capacity management is that planned volumes necessitate thorough planning, whereas on-demand manufacturing primarily depends on scheduling.

Deep dive: Capacity management for planned volumes

In the planned volumes scenario, there are three points in time with varying deadlines depending on the product being manufactured or the users' needs (Exhibit 8).

Exhibit 8:
Capacity management for planned volumes



Uncertainty

Source: Y. Boulaksil Y, J. C. Fransoo, 2010, Implications of outsourcing on operations planning: findings from the pharmaceutical industry
 Note: ¹ Deadlines as orientation, they can vary depending on project ² Depending on the contract, in some cases there might be no penalties for cancellations ³ The deadline to change the order can vary depending on contract

- The first of these points is capacity reservation. At this stage, forecasts of the anticipated capacity needs are provided, and capacity is reserved. The Operator/Asset Producer can accept, modify, or reject these reservations based on the total capacity of the production line.
- After capacity reservation, order placement occurs. Order placement is the confirmation of the required parts/products that will be needed. Ideally, the confirmed parts do not deviate significantly from the capacity reservation. Depending on the contract between the Operator/Asset Producer and the Asset User, a penalty may be imposed if the final order placement is smaller than a certain percentage of the reserved capacity.

- The period between order placement and the delivery date is considered the lead time. A minor variation in the required products might be introduced during the lead time. However, a sufficient time before the delivery date must be ensured to enable the Operator to accommodate this last-minute variation.

The characteristic that distinguishes these three points in time is uncertainty. Uncertainty decreases the closer we get to the delivery time, making it easier to provide specific numbers. This is why order placement can differ from capacity reservation, as it is assumed that uncertainty is too high to provide precise product quantities when making capacity reservations.

Deep dive: On-demand manufacturing

In on-demand manufacturing, uncertainty is eliminated as users directly approach the Operator with the required quantity of products to be manufactured.

The make-to-order scheduling strategy is employed, with production commencing immediately after the order has been placed. Various strategies can be used to sequence the production orders, including but not limited to:

- Earliest due date: Orders with the earliest due date are processed first.
- Optimization: Orders are processed to minimize setup times, so the total processing time of all orders is optimized.
- First come, first serve: Orders are processed according to the order of their entry date.
- Shortest process time: Orders with the shortest overall process time are prioritized.

These scheduling strategies are intended to minimize inventory costs and waste. As tardiness is a common challenge for these strategies, the control and reliability of the supply chain must be high to avoid excessively long lead times, and economies of scale may be reduced.

The market perspective

Overall, it is clear that asset sharing is not a new concept and has been a successful dimension of business models across various industries. However, sharing within the manufacturing sector introduces complexities that must be resolved by one of the involved parties. As the primary benefit of sharing lies in higher utilization of the underlying assets, the interviewed managers of Asset Producers generally believe that greater use of sharing would be advantageous for them. It could provide access to target groups and markets that are currently too small to serve. At the same time, they almost universally emphasized the importance of addressing IP and data security concerns as a crucial prerequisite for successful sharing within the manufacturing sector.

02

User Perspective

The Key Takeaways

- PaaS models only deliver value if Asset Users see operational and financial advantages by using them.
- Regionalization strategies can benefit from PaaS given lower entry barriers and Capex investments necessary to operate local production sites.
- Balance-sheets impacts are a driver of the current generation of PaaS offerings, but heavily depend on IFRS/ accounting interpretation.
- Users also benefit from a lower capital intensity and a better alignment of cash outflows from the investment in the asset (cash flow matching).

Developing a PaaS offering is only justifiable if it offers advantages to Asset Users compared with the existing OTS model. Thus, it is essential to understand how Asset Users can benefit.

Broadly, the advantages can be categorized into strategic benefits and financial benefits. The former includes competitive advantages such as the acceleration of regionalization considerations or the introduction of new technologies. The latter encompasses efficiency gains through additional services or higher utilization, as well as balance sheet implications such as Capex versus Opex considerations. In this chapter, we will delve deeper into regionalization and the broader financial implications for Asset Users.

Regionalization

The use of PaaS is promoted by regionalization – a manufacturing strategy in which companies establish multiple smaller factories close to where their products are consumed, rather than having a single global factory serving multiple markets simultaneously. Regionalization plays a vital role in helping industrial players, machine builders, and manufacturers address multiple challenges:

Geopolitical risk. After an era of globalization, countries are increasingly focused on securing their power and local economies, resulting in protective tariffs. This trend may gradually lead to trade wars in which both sides (for example, the West and China) isolate their markets. Individual countries and geopolitical blocs are exploring how to decouple and de-risk their economic relationships. Companies must consider the implications of these moves for their supply chains and manufacturing strategies. Another potential consequence of geopolitical risk is evident in the sharp increase in energy costs in Europe, primarily due to the shortage of Russian gas resulting from Russia's invasion of Ukraine.

How regionalization helps: By producing closer to the actual demand, companies can diversify their production portfolio and become more flexible in adapting to changing market environments.

Supply chain disruptions. Given the extensive interconnections that emerged through globalization, local disruptions almost always have global consequences. For example, severe weather conditions, diseases, or shortages in critical resources can have far-reaching effects. These regional phenomena have the potential to slow down or even halt entire supply

chains, creating complex situations for manufacturing worldwide.

How regionalization helps: In a decentralized production network, long and complex supply chains can be minimized, consequently increasing the resilience of their logistics.

Climate change. The profound impact of climate change is already leading to changes in customer behavior, with a product's manufacturing footprint becoming a selling point. Additionally, an increase in CO2 pricing will affect global logistics, and companies will need to navigate regional climate policies.

How regionalization helps: By focusing on higher utilization of local factories, companies can reduce their overall carbon footprint because products are produced where they are used. Furthermore, sharing production assets makes it unnecessary to have multiple underutilized small factories that never reach economic sustainability.

Labor shortage. Aging societies in various countries will significantly affect the manufacturing industry, and solutions must be identified today. The lack of skilled workers can limit growth, raising existential questions for production sites. Simultaneously, the bargaining position of the remaining employees improves, leading to increased wages. As a partial response, the role of automation in industrialized countries will increase, necessitating investments in new technology and in reskilling the workforce.

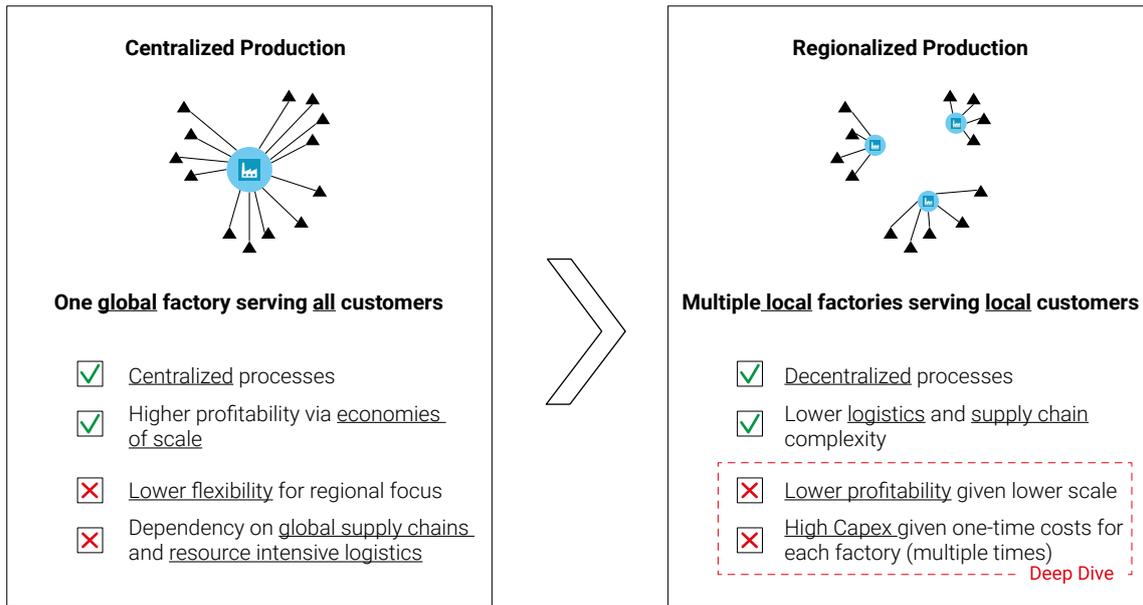
How regionalization helps: Regionalized production offers a partial solution to labor shortages by providing access to a global talent pool on a smaller scale instead of relying on just one market. Similarly, concentrating on larger, fully automated shared sites promotes the use of socially responsible factories where workers can focus on skilled tasks instead of repetitive ones.

Regionalization focuses on proximity and simplified logistics

Although regionalization offers benefits, the choice between a centralized or decentralized approach depends on the complexity of logistics and the role of economies of scale (Exhibit 9). Opting for centralized production is often the economically sound choice and easier to manage for companies, as logistics are outsourced.

Exhibit 9:

Regionalization is focused on proximity and simplified logistics



Choosing regionalized production, however, is often characterized by lower profitability and high capex, as the setup costs for a factory must be covered multiple times instead of just once. Therefore, it is crucial to thoroughly understand the core challenges and identify measures to address them, as discussed in the following sections.

How PaaS enables the regionalization of manufacturing

Two central challenges hinder the broader application of regionalization, both having a profound effect on the profitability of the underlying manufacturing setup. First, a decentralized, regionalized approach often involves multiple smaller factories replacing a small number of larger factories. These smaller factories lack the scale necessary to deliver attractive economics. Second, the capex required to build a factory – characterized by a large share of fixed setup costs – is multiplied by the number of factories to be built. Thus, a regionalized approach results in a significantly higher capex requirement for manufacturers.

PaaS addresses both core challenges of regionalized production.

— **Low economies of scale.** The challenge of low economies of scale due to small factory size is addressed by sharing. PaaS enables optimal utilization of local factories by sharing production capacity among multiple users.

Since multiple users bundle their production capacity, there is enough demand to build larger factories, which in turn can generate sufficient economies of scale. Consequently, users in a PaaS setting can benefit from automation and scale even with small lot sizes. Additionally, fluctuations in regional market demand can be mitigated by including more companies.

— **High capex.** Simultaneously, the high capex arising from investing in multiple factories can be countered with financial transformation. PaaS allows manufacturers to access external capital to fund multiple local factories and utilize production capacity on a pay-per-use basis. Since focusing on a regional manufacturing strategy requires multiple investments in infrastructure and additional setup costs, capex is a crucial factor that manufacturers must manage. A more flexible pay-per-use model effectively reduces capex, as the total cost is distributed over an asset’s entire lifecycle rather than being heavily concentrated at the time of investment. By providing full cost transparency, this approach makes analyzing regional performance much easier.

Financial transformation

To analyze the financial transformation from the Asset User perspective, we considered the implications for the balance sheet and total costs. In addition,

we analyzed the sensitivity of the net present value (NPV) of free cash flow to the actual utilization of the asset. The focus of the analyses has been solely on the production asset.

Modeling the financial impact of PaaS for the Asset User and Asset Producer

Commonly presented financial advantages of PaaS for the Asset User include Capex savings and higher financial flexibility due to a greater share of variable costs. However, these usually come with higher costs at the expected utilization, as the contractual partner of the Asset User (the "PaaS Provider") aims to generate a profit from the offering. A PaaS Provider is typically an Asset Producer seeking to establish a new customer relationship and increase sales. However, Anchor Asset Users can also lead the establishment of a PaaS setting and earn revenue by selling manufacturing capacity.

To illustrate the financial impact of PaaS, we compare a possible PaaS offering without sharing to the direct acquisition of an asset (one-time sale). The asset is priced at €1 million for the direct acquisition. While the asset is expected to have a useful life of seven years, the user plans to use the asset only for three years. Consequently, the user enters into a PaaS contract for just three years. Maintenance, installation, and de-installation services are included in the PaaS offering, whereas they are additional procurements in

the direct acquisition. The asset is operated by the user in both scenarios.

The pricing assumes a mix of a fixed payment ("floor") and a variable payment ("pay-per-use"). The payments calculation assumes that 50 percent of the depreciation of the asset is covered by the fixed payments and the remaining 50 percent by the variable payments. The PaaS provider considers an additional margin of 15 percent on the fixed payment and 20 percent on the variable payment. The calculation of the variable fee further assumes an expected average utilization at 70 percent of available machine hours.

It is important to bear in mind that this is only an example – PaaS offerings can be priced and structured in different ways in accordance with the concrete objectives to be met for the involved partners. While parameters in this example are not an actual offering, they reflect typical expectations voiced by asset providers in the expert interviews.

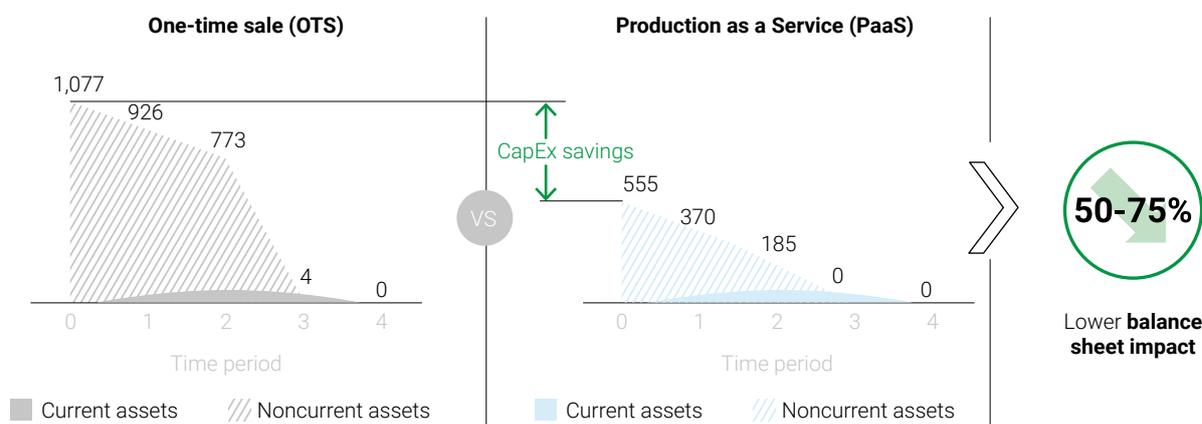
Balance sheet

We analyze the financial impact on users' balance sheets based on International Financial Reporting Standards (IFRS) accounting rules (Exhibit 10). Please note that accounting best practices for PaaS are not yet fully established and will likely depend on how the arrangement is structured. Different auditors may interpret the standards differently. The following should not be interpreted as accounting advice but is likely to reflect a conservative interpretation of the IFRS.

Exhibit 10:

Balance sheet impact of Asset User is reduced through pay-per-use

Balance sheet of Asset User for single machine in [k€]



Note: PaaS setup is modeled as operating lease (balance sheet impact)

If the user acquires the asset, it will have to capitalize the acquisition price together with the cost to put the asset into operation. This amount is then depreciated over the useful life of seven years. Because the user only requires the asset for three years, the example assumes that the asset is sold at book value on the secondary market after that period.

The PaaS offering as described above will likely be considered a lease under IFRS 16. In this case, the user must capitalize a right-of-use asset amounting to the NPV of fixed payments and recognize a corresponding lease liability. The right-of-use asset and lease liability are then amortized over the term of the PaaS contract. As a result, investing and financing cash flows are presented, leading to zero net cash flow at the inception of the contract. This reflects the financing component inherent to PaaS.

Because the capitalization is limited to the fixed fees, the balance sheet impact and capex presented in the cash flow statement are reduced by approximately 50 percent. The balance sheet impact could be further minimized if the Asset User and PaaS provider agreed on a lower share of fixed payments.

Depending on the structure of the arrangement and the auditor's interpretation of the IFRS, complete off-balance sheet solutions are possible. Given the absence of best practices, companies should consult the auditor before making a decision.

We discussed accounting practices under IFRS in the interviews conducted for this study. Off-balance sheet accounting was the primary motivator for Asset User interest. At the same time, manufacturers face difficulties understanding the interpretive leeway within these standards, which results in considerable legal and accounting complexity.

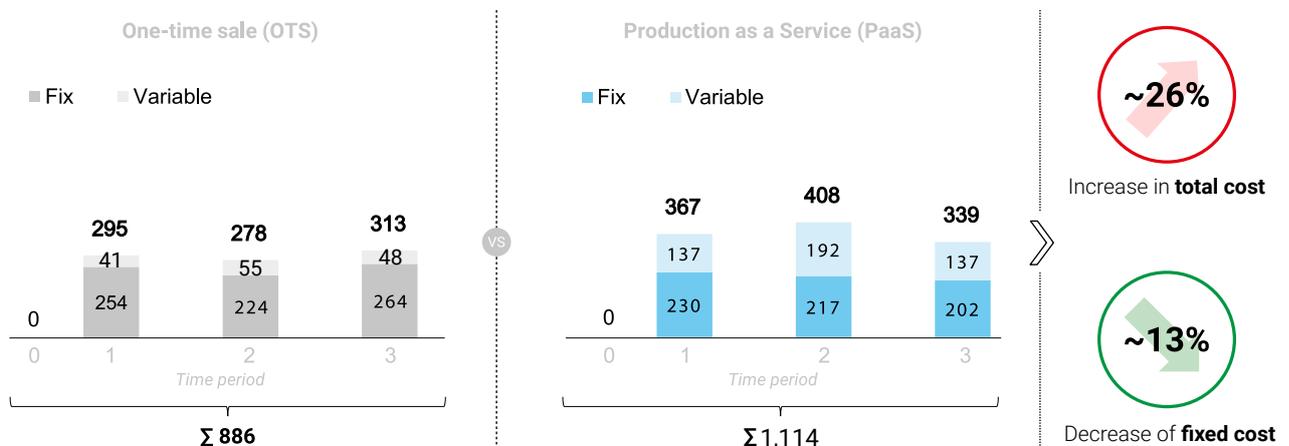
Fixed costs decrease, but total costs increase as the Asset Producer assumes risks

The costs of the direct acquisition primarily relate to the depreciation of the asset. For a like-for-like comparison, we also consider the cost of financing the asset at an interest rate of 10 percent (Exhibit 11). Maintenance and other services that are part of a PaaS offering are presented as variable costs.

Exhibit 11:

Fixed costs of Asset User decrease, but total costs increase as Asset Producer takes over risks

Total manufacturing costs of Asset User for single machine in [k€]

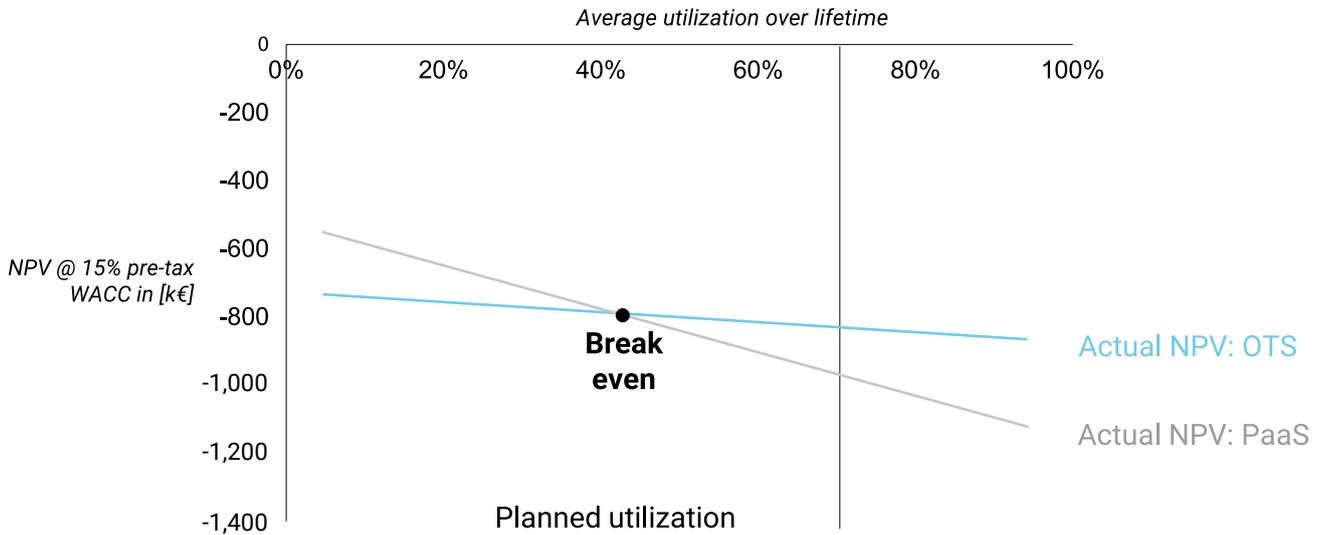


Note: PaaS setup is modeled as operating lease (balance sheet impact) Asset User finances equipment through loan in OTS scenario; 50% pay-per-use share in asset pricing; Fixed costs: Depreciation, installation/deinstallation, fix asset fee (floor); Variable – Variable asset fee (pay-per-use), material, personnel, energy, maintenance service, repair material; Asset User sells asset on secondary market at book value after year 3

Exhibit 12:

Asset Users save money if they underutilize equipment

Sensitivity analysis of planned vs. actual volume for Asset User



Note: ¹ Decrease in utilization is assumed to be at constant proportion to planned utilization; only costs considered for user (no revenues); NPV – Net present value There is an additional timing risk if PaaS fees remain constant over time, i.e. NPV of payments is reduced if PaaS asset is used earlier in time

For PaaS, under the accounting treatment described above, the guaranteed payments are split into the amortization of the right-of-use asset and lease liability and an interest expense on the lease liability. Both of these are presented as fixed costs in the exhibit. Pay-per-use payments are expensed as they accrue and are fully variable with the actual utilization of the machine – that is, they are zero if the machine is not used.

Sensitivity analysis

To support an investment decision, we calculate the NPV of the free cash flow for both scenarios and its sensitivity to the actual utilization of the asset (Exhibit 12). The direct acquisition of the asset shows low sensitivity to utilization, as we assume that maintenance and other services provided by the Asset Producer are at least partially variable with the utilization.

PaaS shows a higher sensitivity to actual utilization, as one would expect. On the chart shown in the exhibit, the intercept of the line with the y axis is dependent on the share of fixed payments and the interest charged on it by the PaaS provider. The slope of the line is dependent on the share of and interest on variable payments.

Both the intercept and slope can further be dependent on the Weighted Average Cost of Capital (WACC). A higher WACC would make PaaS more attractive for the user, all other things being equal. However, if the higher WACC is due to a user’s lower creditworthiness, the PaaS provider might consider a higher credit spread in its pricing.

As expected, PaaS is more expensive compared to the direct acquisition at the expected utilization of 70 percent. It is only cheaper for the user if it reaches a utilization below approximately 40 percent. However, the contract is priced on the assumption that this level of utilization is unlikely.

Consequently, the user mainly benefits in two ways: first, the lower capital intensity of PaaS and, second, cash flow matching – that is, a better alignment of cash outflows from the investment in the asset with cash inflows from the utilization of the asset compared to traditional financing solutions.

03

Asset Producer Perspective

The Key Takeaways

- Offering PaaS should be considered by Asset Producers only if there is concrete demand or a clear business objective (e.g., increasing service or gaining data).
- PaaS can have an overlap leasing offerings; thus, partnering with a finance expert is crucial to understand accounting implications.
- A cash gap in the first years can yield an unpleasant burden for Asset Producers while PaaS promises more cash over the entire lifetime compared to a OTS.
- Establishing a recurring revenue model requires adjustments to e.g., sales, pricing, or KPIs and must therefore be accompanied by organizational changes.

Asset Producers manufacture the equipment used in a production plant. They also participate in developing the production concept and required technology. Offering a PaaS model is essentially entering a new business model for Asset Producers, with significant implications for many functions.

Summary from expert interviews with Asset Producers

During our interviews, company representatives highlighted access to new markets as a primary motivator for establishing a usage-based asset model. Two of the four managers with already established initiatives further stressed the attractiveness to enter the secondary market of used machinery and the opportunity to understand how customers use their machinery as core drivers. Also, accounting and financial factors in form of Capex to Opex shifts as well as off-balance sheet solutions are demanded by their customers. However, less tangible benefits were also mentioned, such as how PaaS enables a complete transition to a cloud-computing environment shared by the manufacturer and its customers, thereby opening up a full suite of additional business opportunities (e.g., data mining).

At the same time, the path towards offering PaaS entails making investments, such as to modify data interfaces or to develop a thorough legal framework. Again, looking at the interviewees with experience in this field, there have been different punctuations regarding the most challenging organizational step. One company focused most of its resources on the data layer while the other one benefited in this case from a strong partnership with a cloud company. Meanwhile, a third player emphasized the legal complexity that has to be solved once. Further the participants agreed on the importance of involving the sales teams early on, as selling as-a-service is more complex than routine one-time sales machinery.

The answers underlined that PaaS must be treated as a long-term investment given its impact on multiple levels of a company. Thus, understanding the financial and organizational implications is crucial, and we analyze them in the following sections.

Financial transformation

To analyze financial transformation from the Asset Producer perspective, we considered the implications for profit and loss, cash flow, and the balance sheet.

We also used a sensitivity analysis to understand how they can tailor the risk-return ratio of their offering.

Profit and loss

We further analyze the impact of PaaS on the Asset Producer, assuming it also serves as the PaaS provider and, consequently, the owner of the asset (Exhibit 13). If a third party (for example, a leasing company or fund) acts as the PaaS provider, there would be minimal changes for the Asset Producer, as they would simply sell the asset to the fund rather than the user.

In this theoretical example, the Asset Producer sells the asset after three years of contract with a PaaS customer at book value. The calculation of a hypothetical profit and loss statement (P&L) intends to showcase how the provision of an asset via as-a-service changes core business metrics such as revenue, costs, and EBT. The high increase in revenue and costs in year 3 is caused by the high cash inflow and the accounting realization of the Cost of Goods Sold (COGS) that is connected to the asset sale. In this regard, there is no intention to take the perspective of an internal cost accounting as manufacturing costs are fully booked in year 3 as opposed to year 0. Due to simplification reasons, this is summarized as fixed costs to display that these costs are not linked to the use of the machine. The P&L calculation has not been discounted to give a more realistic impression on how KPIs are impacted.

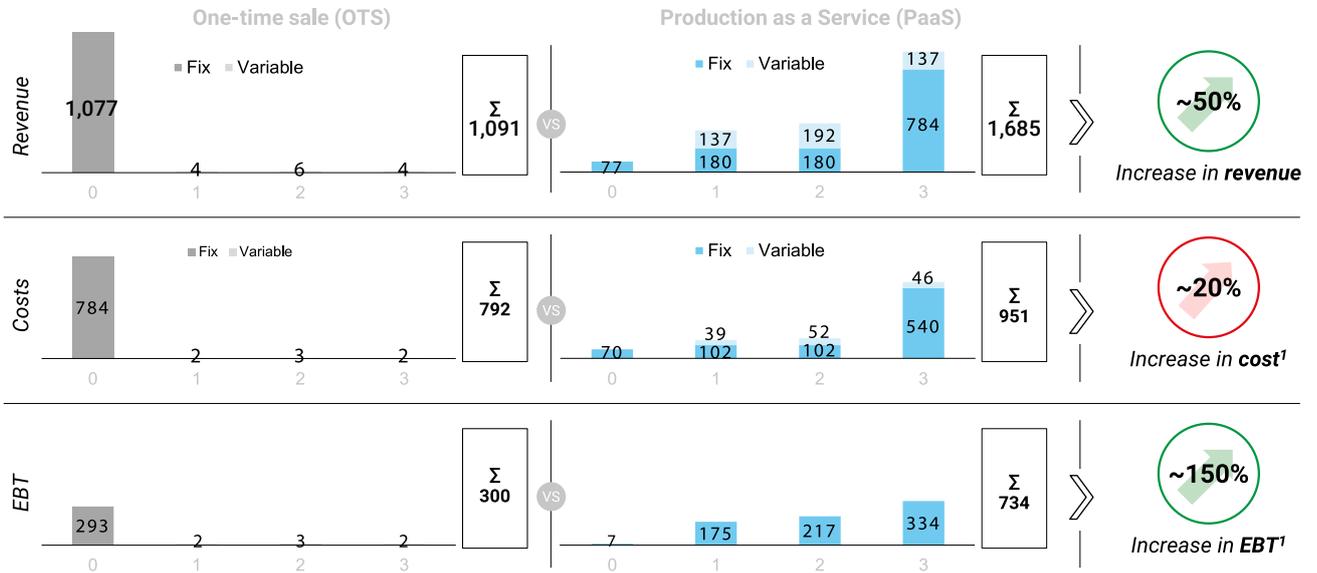
As with PaaS users, no accounting best practices have been established for providers yet, and PaaS contracts could be classified as leases. Although the distinction between finance and operating leases has been discontinued for lessees with the introduction of IFRS 16, it still exists for lessors. However, if the pay-per-use fees constitute a significant portion of the total payments, the contract is likely to be classified as an operating lease.

If the contract is classified as an operating lease or not classified as a lease at all, revenue will be earned as PaaS payments are made (both fixed and variable). As a result, revenue will be distributed over the contract's lifetime, rather than being recognized solely at the time of sale. The asset will be maintained as a non-current asset and depreciated over its useful life.

If the asset is not offered for PaaS after the contract's term and is sold instead, the proceeds from the sale will be classified as revenues. The exhibit assumes a sale of the used asset in the final year of the contract.

Exhibit 13:
Asset Producer can gain higher revenue and profit from PaaS

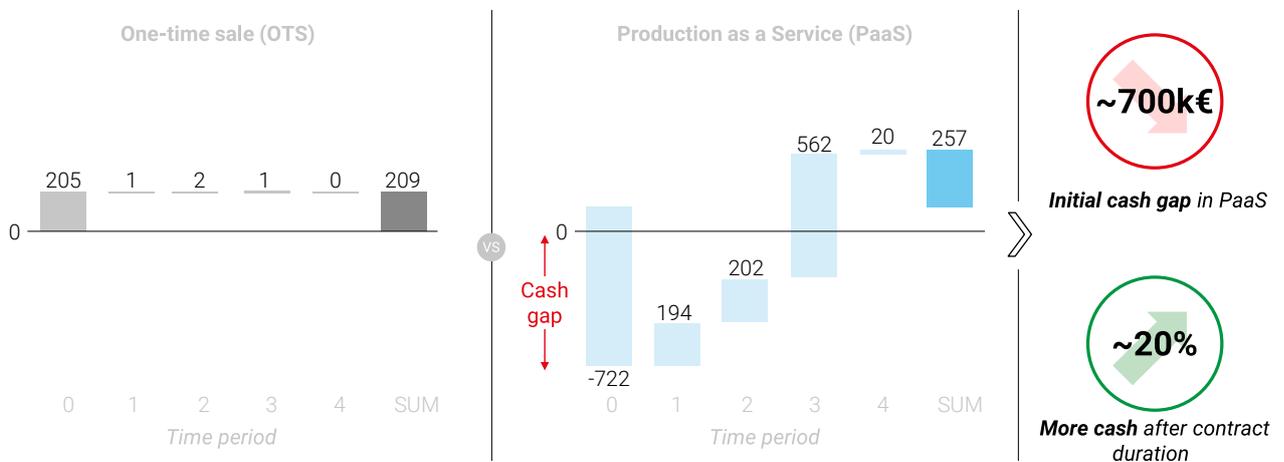
P&L of Asset Producer for single machine in [k€]



Note: ¹ No cost for re-financing of asset producer included; Fix revenue: fix asset fee (floor), installation/deinstallation fees; Fixed costs: mfg costs of asset, depreciation, installation/deinstallation costs; Variable revenue: Variable asset fee (pay-per-use), repair material other services (personnel, energy); Variable costs: Energy, repair material, personnel

Exhibit 14:
While PaaS yields higher cumulated cash over contract period, Asset Producer must overcome initial cash gap

Cash flow of Asset Producer for single machine in [k€]



Note: Asset Producer sells asset on secondary market at book value after year 3 in PaaS scenario; Cash flow is discounted with a WACC of 10%

Cash flow

While the financial comparison for the Asset User in the previous chapter assumed that the Asset User procured additional services from the Asset Producer for a like-for-like comparison, this chapter's comparison includes fewer service revenues in the one-time sale to illustrate the benefits of upselling. This reflects the reality that, currently, only a minority of Asset Users procure additional maintenance services from the Asset Producer.

In the OTS scenario, the Asset Producer pays all cash to manufacture the asset in year 0 and receives the total cash amount at the time of sale, also in year 0 (Exhibit 14). This leads to a positive net cash flow equivalent to the margin charged on the asset. Future cash inflows represent minimal necessary maintenance services.

In the PaaS scenario, the Asset Producer pays all cash to manufacture the asset in year 0 and receives the PaaS payments starting from year 1. The cash flow in the final year also includes the proceeds from an assumed sale of the asset on the secondary market at book value. Alternatively, re-offering the asset under another PaaS contract or extending the existing PaaS contract would provide a continuous cash flow for the Asset Producer instead of a lump sum payment in year 3.

The example illustrates that with PaaS, a cash gap exists in the first years of the contracts, but the PaaS

provider can generate more cash overall compared to the OTS. As the proceeds are shifted backward, the Asset Producer requires long-term refinancing of the manufacturing costs. This might pose an unwanted burden on the Asset Producer. The increase in cash is due to the additional margin included in the PaaS offering (financing) and the sale of additional services. The coupling of PaaS contracts with additional maintenance services is recommended not only to extend the Asset Producer's topline but also to closely monitor the condition of the machine and prevent adverse developments. This helps to minimize the risk of a loss on the sale of the asset after the conclusion of the contract (see also the discussion of the residual value risk in the Investor chapter below). It is important to note that the cashflow has been discounted with a weighted average cost of capital (WACC) of 10% assuming Asset Producers have a sufficient size and rating.

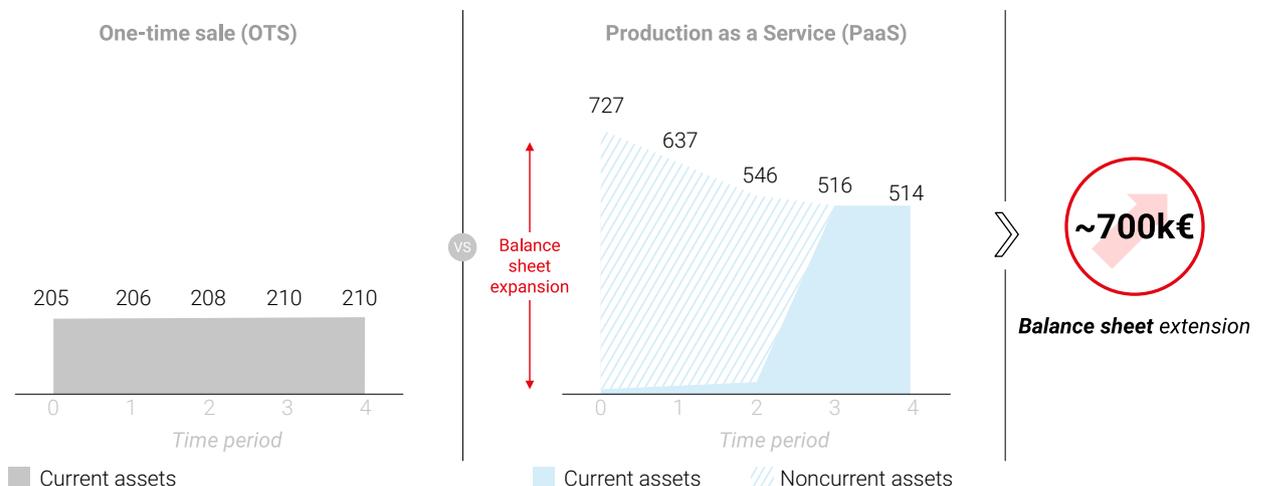
Balance sheet

The cash gap, of course, also impacts the balance sheet (Exhibit 15). As discussed earlier, the asset must be capitalized at its inventory value and depreciated over its useful life (not the term of the PaaS contract). This results in the extension of the balance sheet and the necessity to finance the initial manufacturing costs over a longer time period. The Asset Producer might, therefore, seek a partner to provide refinancing if it intends to offer PaaS at scale.

Exhibit 15:

PaaS leads to balance sheet expansion of Asset Producer

Balance sheet of Asset Producer for single machine in [k€]

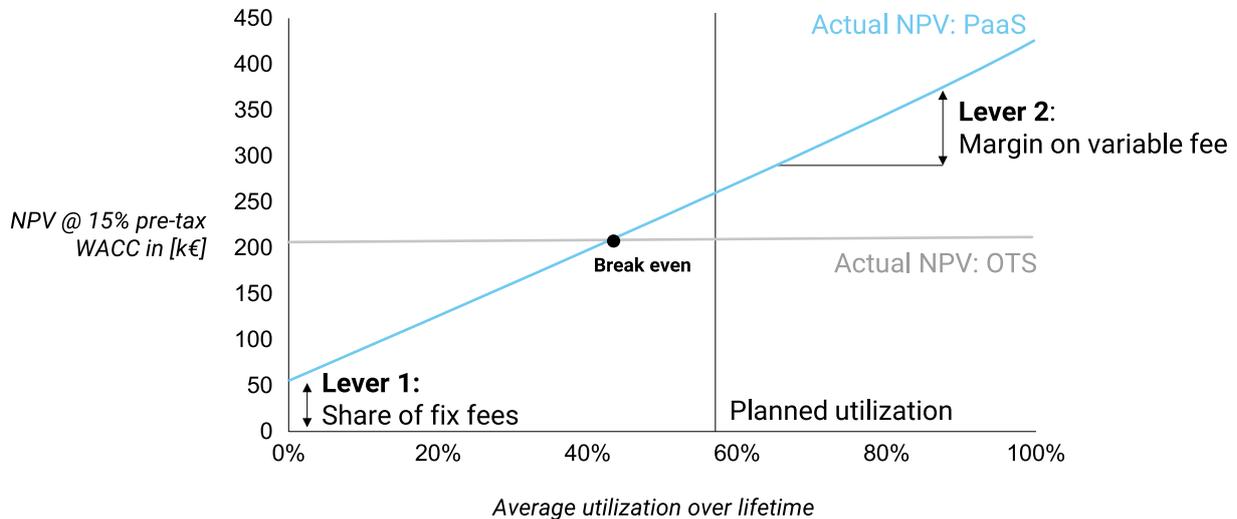


Note: Asset Producer sells asset on secondary market at book value after year 3 in PaaS scenario

Exhibit 16:

Asset Producers can tailor the risk-return ratio of their aaS offering with two main levers

Sensitivity analysis of planned vs. actual volume for Asset Producer



Note: Decrease in utilization is assumed to be at constant proportion to planned utilization; AP – Asset producer, OTS – One-time-sale, NPV – Net present value There is an additional timing risk if PaaS fees remain constant over time, i.e. NPV of payments is reduced if PaaS asset is used later in time

The Asset Producer’s involvement in operating the machinery or the provision of additional services can come with additional working capital requirements. However, this effect is overshadowed by the balance sheet extension resulting from the continued ownership of the asset. (Note: Current assets primarily include cash from the sale of the asset.)

Sensitivity analysis: Asset Producers can tailor the risk-return ratio of their offering with two main levers

As with the user, we calculate the NPV of the free cash flow in both scenarios for the Asset Producer and their sensitivity towards the actual utilization of the asset (Exhibit 16).

In the example, PaaS reaches the break-even point after the cost of capital for the provider at approximately 40 percent utilization. At the expected utilization of 70 percent, PaaS offers a margin for the provider on top of the cost of capital. The provider can tailor the payoff function to its preferences by increasing the share of

guaranteed versus variable payments – thereby raising the intercept and decreasing the slope. Increasing the margin on the variable payments increases the slope. A lower WACC further enhances the attractiveness of PaaS to the provider but might have to be passed on to the user via pricing, as PaaS competes with traditional financing products. If an Asset Producer offers PaaS, it will need to price the offering to avoid taking a loss on PaaS compared to an OTS.

Operational and organization structure

Asset Producers developing PaaS offerings must also consider the implications for their organizational model.

PaaS requires a transformation for Asset Producers across various organizational dimensions

The 7-S model can be utilized to facilitate organizational change and provides a theoretical foundation for understanding organizations and the aspects in-

fluenced by transformations (See Exhibit 17).⁴ The model's objective is to demonstrate how the seven elements of a company can be aligned to achieve effectiveness. The crucial aspect of the model is that all seven areas are interconnected, and a change in one area necessitates changes in the rest of the firm for it to function effectively.

⁴ Ravanfar, 2015, Analyzing Organizational Structure Based on 7-S Model of McKinsey, Global Journal of Management and Business Research: A Administration and Management, 15(1)

Adopting an aaS business model within an existing organization: Three essential "S" components

Implementing an aaS business model can be accomplished within an existing organization. The key lies in striking the right balance between one-time transactions and recurring lifetime revenues. Some manufacturing companies aim to generate 20 to 30 percent of their total sales revenue from recurring business models. Because an aaS organization is set up within an existing company, not all elements of the 7-S model have the same strong influence on its success, as these elements are defined at the corporate level.

With this in mind, the three critical pillars for an aaS business model are strategy, structure, and skills.

Strategy: Develop a new strategy and goals, which must be measured using new KPIs. Create a roadmap and implement performance metrics tailored for a subscription-based business.

Structure: Adapt to different functions and adjust the legacy organization. Assess the current status of the aaS journey and select the appropriate organizational structure.

Skills: Identify new tasks requiring specific skills found either internally or externally. Determine the necessary skills across key functions to assign existing employees or recruit new staff.

Asset Producers: Evaluating the aaS business model and developing a strategic rationale for market entry

In strategic business planning, a SWOT analysis is a common tool used to organize and present information in a structured manner (Exhibit 18). It iden-

tifies the strengths, weaknesses, opportunities, and threats of a project or organization, helping to shape a long-term success strategy. The company uses the information to determine the requirements for the aaS offering and the organization. Subsequently, it defines the roadmap for the offering and the aaS business model.

Deep Dive – Strategy: Three transformational phases

Based on its current offerings, an Asset Producer can chart a roadmap for transforming its business model. There are three phases to transition an Asset Producer from conventional OTS to an aaS provider (Exhibit 19):

1. Harvest low-hanging fruits: To provide alternatives to OTS for its customers, the Asset Producer can partner with leasing firms to offer traditional leasing models. This allows the Asset Producer to gain experience with offerings that couple an asset with additional services, as well as gather initial insights into negotiating contracts involving multiple parties.

2. Develop a Minimum Viable Product (MVP): The next step involves developing an MVP to introduce to the market. First, based on an analysis of one's offerings and the requirements for a PaaS offering, a use case must be defined upon which the MVP can be built. Then, for this use case, a basic PaaS offering – preferably for a specific customer – is developed, bearing in mind all necessary organizational interfaces. Subsequently, a pragmatic billing solution must be set up based on the available IT infrastructure, possibly requiring manual workarounds. Once these tasks are complete, the MVP can be deployed to customers, marking the creation of the first true PaaS offering.

3. Scale the aaS offering: Once the MVP starts gaining market traction, the final phase is to scale the offering based on the lessons learned. This involves finding suitable strategic financing partners and integrating IoT solutions and IT systems to ensure the efficient service level needed for minimal downtime. It also requires implementing a professional billing and payment solution based on the IoT data.

The 7-S model describes the theoretical background of organizations and aspects affected by transformations

	Description¹	Sample questions to answer
Strategy	Strategy is a plan developed by a firm to decide on how to allocate resources with the objective to reach its goals and achieve a sustained competitive advantage.	e.g., What are the central objectives when offering these two new products?
Structure	Structure represents the way business divisions and units are organized and includes the information who is accountable to whom and responsible for what (i.e. org chart).	e.g., Does the new offering around two products require a new business unit or new department?
Systems	Systems are the processes and procedures, which reveal a business' daily activities and how decisions are made.	e.g., Which processes should be changed to have a smooth implementation of two new products?/ Which processes could prevent/ support the implementation of the new offering?
Skills	Skills are the abilities/ competences that an organization's employees need in order to perform essential tasks.	e.g., Does the organization possess the know-how (in production, pricing, ...) to offer these two new products?
Style	Style represent the way a company is led by its decision makers and what role they play within the organization.	e.g., Is the management willing to offer these two new products that are new to the market?/ Does the product require a reactive or active management style?
Staff	Staff element is concerned with what type and how many employees an organization will need and how they will be recruited, trained, motivated and rewarded.	e.g., Which and how many employees are needed for producing two new products?
Shared Values	Shared Values are the commonly accepted norms and standards that both influence and temper the behavior of the entire staff and management.	e.g., What are the company guidelines saying about offering two new products?

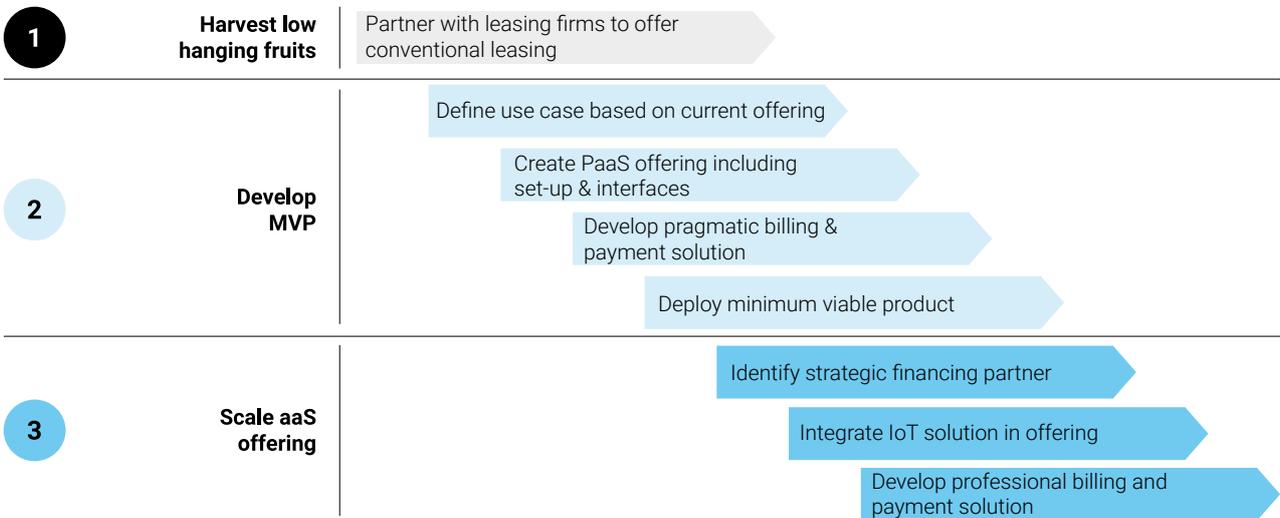
Source: ¹ M. M. Ravanfar, 2015, Analyzing Organizational Structure Based on 7-S Model of McKinsey, Global Journal of Management and Business Research: A Administration and Management, 15(1)

Strategy – the aaS business must be evaluated from different perspectives

Status quo	Strengths	Weaknesses
	— Customer access (e.g., existing customer contacts can be utilized for marketing activities)	— Low commercial know how (e.g., one-time sale business vs. recurring business model)
	— Technical know-how (e.g., knowledge about own plants are available in the company)	— Low implementation pace (e.g., hierarchization makes implementation of innovations complex)
	— Established brand identity (i.e., customers already know and trust the company)	— Fear of change (e.g., partly conservative attitude towards innovations)
	— Skilled workforce (e.g., services around assets can be carried out by own staff)	— Limited budgets (e.g., only a small budget is available for innovations)
	— Investments in service (i.e., service offerings are part of the core business)	— Decreasing revenue (e.g., in case of declining sales, the investment in the change is unlikely)
PaaS perspective	Opportunities	Threats
	— New markets (e.g., small customers that can't afford purchase or young companies that do not have credibility yet for leasing)	— Financial failure (e.g., inflation of costs / no demand / low budget for innovation)
	— Extended customer relationships (e.g., higher customer centricity, focus on service and recurring revenue business model)	— Complexity (e.g., wrong pricing strategy / change management doesn't work)
	— Data-driven innovation (e.g., Use the data of your installed equipment for product innovation)	— Cultural fit (e.g., less shared values / contrast to one-time sale business)
	— Higher profits (e.g., commercialize higher flexibility via recurring revenue)	— Tracking (e.g., wrong KPIs to measure success/ impatience regarding speed of success / wrong objectives)
	— Differentiation (e.g., achieve unique selling proposition (USP), first-mover advantage)	— Communication (e.g., external: misleading marketing / internal: less project communication)

Strategy – three phases to transform Asset Producer from conventional one-time sales to “aaS” provider

High-level transformation roadmap



Note: MVP – Minimum Viable Product

Deep Dive – Strategy: Adapting KPIs

KPIs typically used by Asset Producers focus on economic valuation at the point of sale – a single moment in time. Consequently, they often focus on traditional KPIs such as revenue, EBIT, order volume, and contribution margin.

While these metrics serve OTS business models effectively, they are less suited for PaaS business models. The primary reason is that for PaaS the observation period spans a length of time rather than a singular point. Therefore, to accurately measure success, new KPIs must account for the economic valuation over the entire asset life what can be calculated via e.g., the Customer Lifetime Value (CLV). Other examples for this are Monthly Recurring Revenue (MRR), earned vs. deferred revenue, Annual Contract Value (ACV), Average Revenue per User (ARPU), churn rates, and Customer Acquisition Costs (CAC).

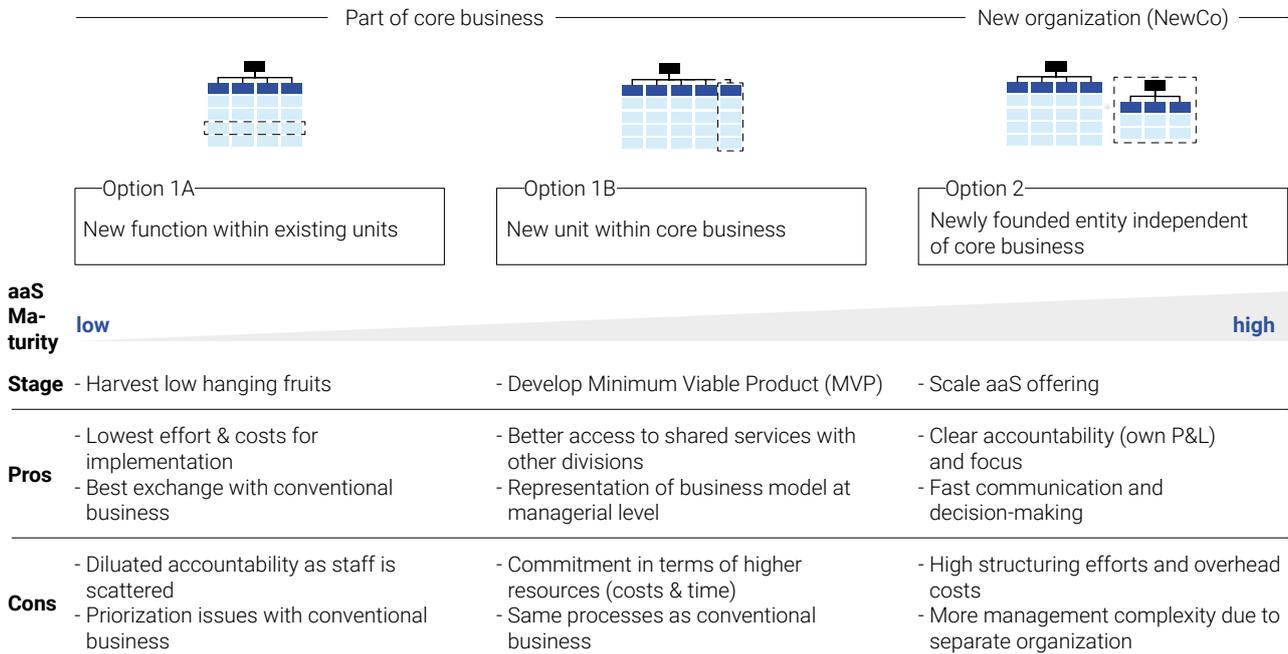
The benefit of these KPIs is that they attempt to surface the true economic value of a business relationship and thereby deliver important information with regards to customer retention and sales strategies. As customers who repurchase machinery or apply

the correct maintenance measures yield in a higher profitability for the manufacturer, the information resulting from these KPIs should lead to more intended business actions and ultimately improved top-level KPIs such as revenue or EBIT. Meanwhile, recurring revenue focused KPIs have the main challenge that they are hard to measure. Further, similar benefits can be derived by breaking down the data by customer size, location, or industry.

To understand what it takes to report on the discussed KPIs, it is beneficial to take a closer look at Customer Lifetime Value as an example. It is calculated by multiplying the customer value with the average customer lifetime. In turn, the customer value is received by multiplying the average purchase value with the average purchase frequency rate. By looking at this simplified calculation, it becomes clear that a lot of data points are needed in order to have reliable figures. Virtually such KPIs only become effective when a product has reached a sufficient size in terms of units sold per month. Also the experiences of interview participants with existing PaaS offerings indicates that transitioning to new KPIs overnight is not realistic. Companies are accustomed to their current performance tracking methods (primarily “outgoing goods”) and also want to compare the new offering to the OTS business. At the same time, these companies are exploring methods to

Exhibit 20:

Structure – options for organizational structures pending on stage of as-a-service offering



monitor KPIs that align better with the actual value delivered to the Asset Producer, as described previously. Moreover, gathering the data required for a recurring business model is significantly more challenging than for OTS KPIs. Given the time required to build corresponding infrastructure, it makes sense to start with common KPIs such as outgoing goods or EBIT and first track recurring KPIs for observation purposes.

Deep Dive – Structure: A stage-based approach

Depending on the phase of the aaS offering, as described above in the transformation roadmap, different organizational structures can promote success (Exhibit 20). To harvest the low-hanging fruits, simply adding new functions within existing units can serve the purpose, requiring minimal effort and cost. For the next stage – the development of an MVP – it is beneficial to establish a dedicated unit within the core business. This ensures necessary management attention and gathers the required expertise and capacity in a single unit. The aforementioned new KPIs come into play here as well. Using a separate set of KPIs to track a dedicated unit may be easier than using these new metrics to monitor various functions scattered across existing units.

Finally, when the aaS offering scales, it is advisable to consider the pros and cons of setting up an independent organization for the aaS business. This is particularly important as managing two distinct cultures and business models can present significant challenges.

Deep Dive – Skills: New capabilities for an aaS model

Managing a successful aaS business model necessitates having new skills, primarily focused on enabling constant support and supervision of production (Exhibit 21). Additionally, specific skills are required to handle the increased legal complexity associated with such business models. The affected areas include Legal, Finance & Controlling, Sales & Customer Service, and IT. During our interviews, we learned that Asset Producers are generally disinclined to consider operating production assets, so Operations is not included in the list of affected functions.

Furthermore, the Legal and Finance departments of industrial companies are typically unprepared for the underlying complexities of a PaaS business model. Consequently, it might be beneficial to outsource some of the necessary skills.

Skills – new skills required for aaS model

Function	Sub-function	Skill
Legal	Legal	Contract design: Define adequate terms & conditions for aaS contract (e.g., collateral, exit, termination, liabilities)
		Liability management: Manage potential legal disputes (e.g., interface b/w operation and asset availability)
		Profitability: Calculate business case for aaS model
Finance	Finance	Risk management: Perform risk management (e.g., utilization, residual value)
		Pricing: Develop pricing logic that reflects assumed risk (e.g., through pay-per-use)
	Controlling	Steering mechanism: Define KPIs and driver tree for measuring success (e.g., customer lifetime value)
		Monitoring: Monitor assets in field continuously (e.g., utilization)
Sales	Sales	Solution selling: Introduce new sales mechanism for solution instead of product (i.e., technical features vs. entire business model)
		Feedback: Establish closer link with finance to adjust pricing for customer requirements
	Customer Success	Customer relationship: Introduce and conduct a continuous touch base with customer (e.g., keep customers informed about technological advances)
		Claim management: Manage claims from aaS contracts (e.g., productivity losses, non-quality)
		Monitoring: Track customer health metrics (e.g., utilization of assets)
		Loss prevention: Approach client in case of continuous underutilization (e.g., termination of contract)
IT	IT	Requirement definition: Define technical requirements to enable aaS solution (e.g., remote maintenance)
		Technical adjustments: Adjust ERP & CRM systems (e.g., implement measuring of new KPIs)
		Risk management: Identify potential risks and handle them (e.g., technology & cyber risks)
		Technical development: Develop software/ hardware based on requirements (e.g., sensors, edge device, IoT gateways)
		IoT: Define interfaces for new as-a-service platform

04

Investor Perspective

The Key Takeaways

- With PaaS, the usage risk is transferred from the Asset User to the investor/ owner of the underlying assets.
- The application of risk management can distribute the risk between all involved parties based on contracting such as e.g., minimum take-over quantities.
- In return for higher risk, investors may charge higher margins and thereby generate higher returns (vs. e.g., classic infrastructure investments).
- The Asset Producer, the Asset User, or a Third-party Investor can be imagined as potential owners resulting in different operating models.

One of the main selling points of PaaS from a financial perspective is the lower capital intensity for the Asset User. However, this goes hand in hand with a higher capital intensity for the PaaS provider, as ultimately someone must finance the assets. Confronted with this challenge, our interview participants unanimously agreed that financing the assets themselves is a burden that almost no Asset Producer is willing to accept. Consequently, they all highlighted the need for a strong and reliable financing partner when developing a PaaS offering.

PaaS is a financing product with new risks

PaaS offerings incorporate a financing component, but compared to traditional financing products, they introduce a new type of risk. Financial institutions and PaaS providers will determine their risk appetite, establish techniques for risk assessment and risk management & mitigation, and charge a premium for the risk they accept. As part of risk management & mitigation, risks might be shared between multiple parties (risk transfer), or the likelihood of occurrence and/or magnitude might be reduced (risk reduction).

Traditional loans expose the lender to counterparty or credit risk, which is the possibility that the borrower does not fully repay the principal and/or interest on the loan. Managing this type of risk is a core competency of banks and lenders.

Operating leases in which payments to the lessor do not cover most of the lessor's initial investment in the asset introduce residual value risk. Lease payments compensate the lessor for interest and the expected loss of asset value over the lease term. If the asset loses more value than initially expected, the lessor will incur a loss. Some lessors opt to make this type of risk their core competency. This is often the case for those dealing with a high volume of liquid assets (for example, cars). When lessors do not feel they can manage this type of risk, they try to avoid it – such as by requesting value guarantees from the Asset Producer or by not offering operating leases for that type of asset.

PaaS also introduces usage risk, as we discuss next.

Comparing PaaS to traditional leasing

Although traditional leasing contracts involve pre-defined payments over the lease term, PaaS payments will vary from one period to another based on the asset's utilization (Exhibit 22). This implies that if the actual utilization of the asset is lower than the utilization assumed in the initial pricing, the PaaS provider might incur a loss on the contract. However, since pricing assumes an expected value of a probability distribution, not maximum utilization, PaaS also introduces a potential upside for the provider – if the actual utilization exceeds the expected one.

Using this approach necessitates that the PaaS provider can predict the asset's utilization and that the probability distribution (after risk management & mitigation) aligns with its risk appetite.

Risk management

PaaS providers can employ various established and innovative risk management and mitigation techniques to align the accepted risk with their risk appetite (Exhibit 23). Some of the most prominent methods for PaaS include:

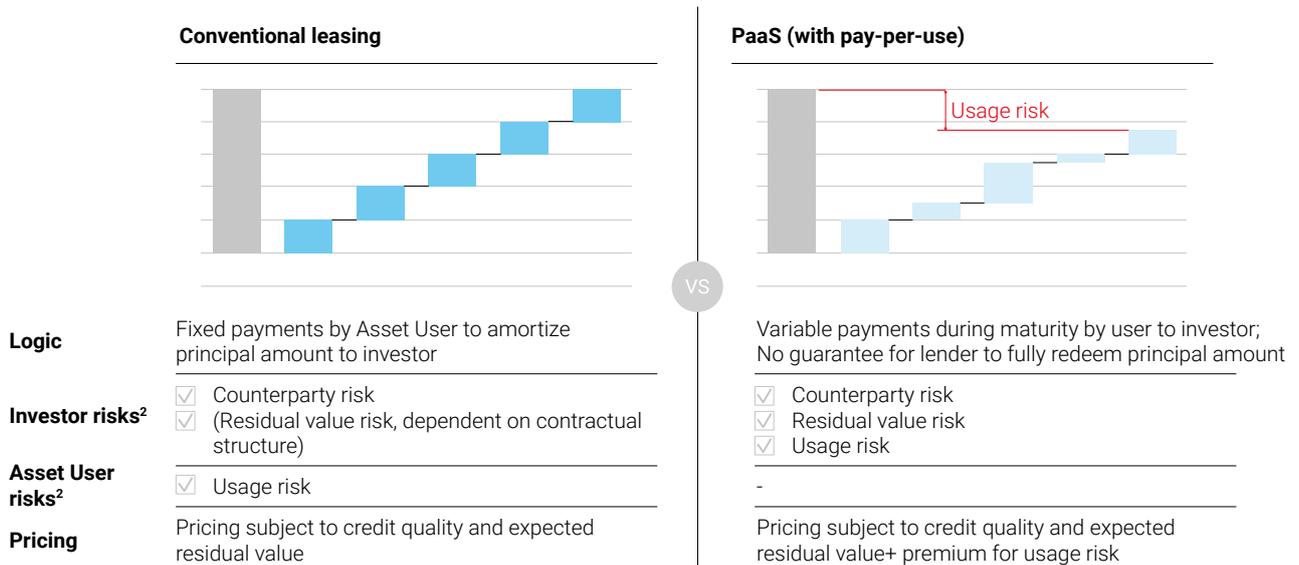
- Offering buyback guarantees to manage residual value risk when the PaaS contract does not cover the majority of the asset's lifetime.
- Providing utilization guarantees by the Asset User or Asset Producer to avoid losses on the principal in the event of under-utilization.
- Having the Asset User or producer participate in, or fully assume, usage risks – for example, by holding the equity tranche in a PaaS special purpose vehicle (SPV) or through other contractual arrangements such as a payment swap.
- Granting the right to exit the contract in case of under-utilization, including the option to offer the asset to another potential user or sell it on the secondary market.
- Sharing the assets between multiple users to introduce diversification in usage risk.

Bear in mind that the party who takes over legal ownership of the asset will affect the risk exposure of the individual parties and the available risk management techniques.

Exhibit 22:

Usage risk – pay-per-use transfers usage risk to investor

The difference between leasing and PaaS/pay-per-use¹

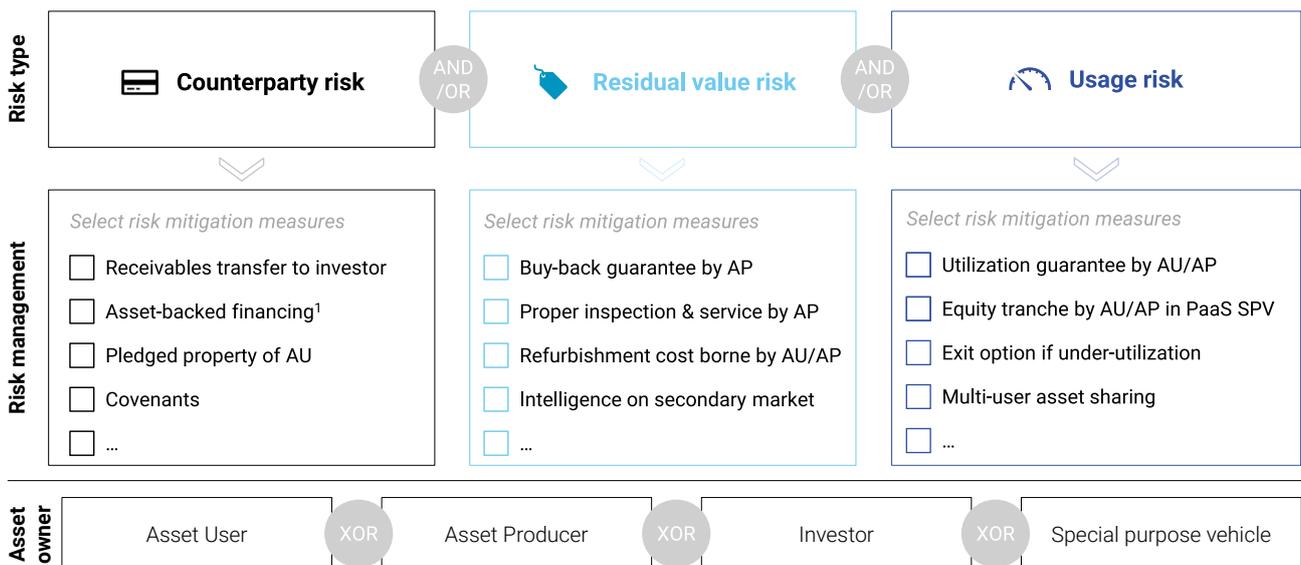


Note: ¹ Interest not considered ² Financial risks only – no technical risks considered (e.g., downtime)

Exhibit 23:

Investors can tailor the assumed risk to their risk appetite

Option space for investors to assume risks in PaaS financing



Note: AU – Asset User; AP – Asset Producer; XOR – Exclusive OR; PaaS – Production as a Service; SPV – Special Purpose Vehicle
¹ Assuming appropriate loan to value ratio

Return potential

Investors have the opportunity to take on more risks compared to traditional financing products and other asset classes (such as infrastructure), which allows them to charge higher margins and generate higher returns. This development establishes PaaS as a new asset class and opens the door for investor-driven PaaS offerings (Exhibit 24). Another factor that influences PaaS's position on the risk-return spectrum is the size and mobility of the underlying assets. Assets that are more complex or specialized and less mobile permit fewer risk mitigation techniques, making PaaS riskier for the Investor.

How the operating model affects the Investor

Investors can participate in PaaS through four operating models, which are dependent on the legal ownership of the asset. Each model has specific advantages and disadvantages for the Investor. A commonality among the models is that, in the absence of additional risk management or mitigation techniques, the legal owner of the asset typically bears the residual value risk, while the PaaS Provider usually bears the usage risk. If the risk does not fit the risk owner's appetite – or it cannot quantify the risk reliably and thus lacks a basis for pricing the PaaS offer – it will seek to reduce or transfer the risk. The ideal or natural

risk owner will have the ability to quantify and reduce risks. Investors are often less skilled at quantifying or reducing residual value or usage risks than Asset Users or Asset Producers, so they will seek to avoid or transfer these risks to other parties.

These are the four models:

Asset User Owns Asset. In this model, while the Investor takes on the usage risk, it lacks the ability to enforce the asset's best use, thus creating a principal-agent problem. The Investor adopting this operating model will aim to limit its risk exposure and find ways to incentivize or force the Asset User to put the asset to its best use. Consequently, this operating model is not suited for "true PaaS".

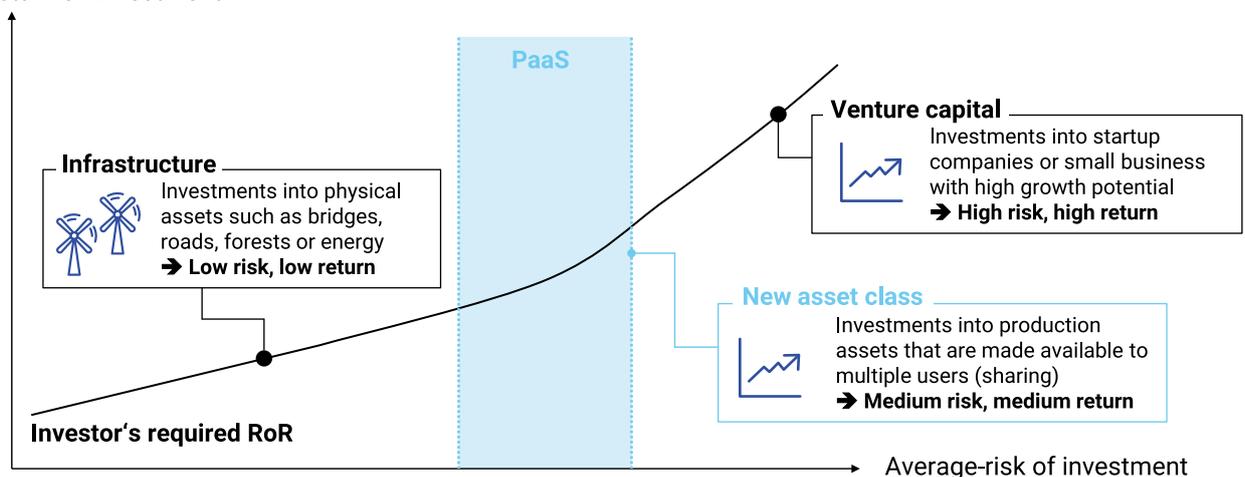
Asset Producer Owns Asset. The Asset Producer likely has better market insights than an Investor and is thus a better risk owner for both usage and residual value risks. If the Investor assumes usage risks, the same principal-agent problem as in the "Asset User Owns Asset" model arises. The problem can be resolved, for example, by including an exit-right for the PaaS provider as a suitable risk reduction technique for the asset in question. This operating model leads to a balance sheet extension for the Asset Producer. Although the model is generally suited for producer-driven PaaS offerings, the balance sheet extension makes it less attractive to the Asset Producer.

Exhibit 24:

PaaS creates a new asset class with medium risk and return profile

Risk/return by asset class

Return of investment



Note: RoR – Rate of Return

Investor Owns Asset. Unlike the “User Owns Asset” model, this operating model allows the Investor to better enforce the asset’s best use, especially if an exit-right is a suitable risk reduction technique for the asset in question. This model requires the Investor to become the natural risk owner of residual value and usage risks or find a suitable method to transfer the risk to a third party (for example, residual value guarantee and usage-linked payment swap). By transferring risk to the Asset Producer, the model enables producer-driven PaaS offerings without a balance sheet extension for the Asset Producer. However, providing guarantees and usage-linked payment swaps comes with an administrative burden for the Asset Producer if it decides to assume the risks in the first place.

SPV Owns Asset. This model allows for risk-sharing of residual value and usage risks with the Asset User and/or Asset Producer if it acquires part of the equity tranche of the SPV. It is best suited for complex assets and asset sharing. It is also a potential solution for producer-driven PaaS offerings with limited balance sheet extension (if at-equity accounting is achieved for a jointly held SPV).

How operating models fit the interests of Asset Producers and Asset Users

The operating model and expected risk management and mitigation techniques applied by the PaaS provider also affect the Asset Producer and Asset User.

Asset User Owns Asset. This model assumes that the Investor and Asset Producer have limited their risk exposure, resulting in no sharing of investment risks. It provides the Asset User with matching financing and operating cash flows during the contract term but exposes it to potential mismatches in the final payment. Because this structure offers limited advantages over traditional financing, it provides the Asset Producer with few benefits over traditional sales financing or few opportunities to sell additional services.

Asset Producer Owns Asset and Investor Owns Asset. In these models, easier resolution of principal-agent conflicts allows for sharing of investment risks. This leads to a higher degree of cash flow matching through the avoidance of mismatches in the final payment. The Asset User’s balance sheet becomes shorter because the asset is owned by the producer or Investor (under IFRS, capitalization of guaranteed payments is required at most, as discussed earlier). If the producer owns the asset, this operating model maximizes its control over

the offering. This provides the highest potential for sales financing and additional services but requires the Asset Producer to deploy its balance sheet. The balance sheet effect can be mitigated through Investor and SPV operating models. However, this will reduce the Asset Producer’s control over the terms of the PaaS offering and, therefore, the potential for sales financing and sales of additional services.

SPV Owns Asset. In this model, it is assumed that both the Asset User and Asset Producer hold the equity tranche of the SPV. This investment in the equity tranche reduces the potential to match financing and investment with operating cash flow, but co-ownership with the Asset Producer allows for some degree of risk sharing. Consequently, the investment in the equity tranche results in some balance sheet impact for both the Asset User and Asset Producer. The complexity of this structure restricts the possibility of sales financing to larger projects. However, co-ownership of the SPV maximizes the potential for additional services provided to the SPV by the Asset Producer.

Examples of potential investor-driven PaaS models

We have identified the possible investor-driven PaaS offerings on the market today, each utilizing different operating structures.

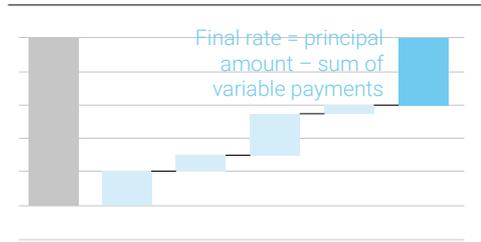
Bank 1: “User Owns the Asset” operating model. The bank offers installment payments that are directly linked to the utilization of the asset (Exhibit 25). In this scenario, the outstanding principal must be fully repaid with the final payment. If the asset is underutilized or overutilized, the final payment will either increase or decrease accordingly. Because the bank does not assume any usage risk, this offer can be categorized as a flexible loan rather than a true PaaS.

Bank 2: “Investor Owns the Asset” operating model. The bank offers fully variable payments linked to the asset’s utilization. This model transfers the residual value risk to the Asset Producer through a residual value guarantee and also fully transfers the usage risk via a payment swap. In this case, the bank only deploys its balance sheet to enable an Asset Producer-driven PaaS offering.

Bank 3: “SPV Owns the Asset” operating model. This is deployed for individual projects and is not a regular offering. The equity tranche of the SPV is held 50-50 by the Asset User and the Asset Producer. The bank then provides traditional loan financing to the SPV. Both the

Bank 1 case – “Pay-per-use credit” offers flexible payments during maturity but requires final rate at the end

Flexible payment with final rate¹



Logic	Variable payments during maturity by Asset User to fully amortize principal amount to investor (i.e., usage-linked amortization timing)
Investor risks	<input checked="" type="checkbox"/> Counterparty risk <input checked="" type="checkbox"/> Duration risk
Asset User risks	<input checked="" type="checkbox"/> Usage risk <input checked="" type="checkbox"/> Operational risk <input checked="" type="checkbox"/> Residual value risk
Pricing	Pricing subject to credit quality and collateral of obligor + premium for flexible payment (duration risk)

Pay-per-use



VS

Logic	Variable payments during maturity by Asset User to investor; No guarantee for investor to fully redeem principal amount
Investor risks	<input checked="" type="checkbox"/> Counterparty risk <input checked="" type="checkbox"/> Usage risk <input checked="" type="checkbox"/> Residual value risk
Asset User risks	<input checked="" type="checkbox"/> Operational risk
Pricing	Pricing subject to credit quality and collateral of obligor + premium for usage risk (if priceable at all)

Note: ¹ Interest not considered

Asset User and the Asset Producer provide guarantees to the bank for the loan. This model allows the bank to offer a conventional loan for a PaaS offering jointly driven by the Asset User and producer.

Venture Debt Company: “Investor Owns the Asset” model. The company offers variable lease payments tied to asset usage. The investment principal must be fully repaid during the lease term, ensuring that the Investor does not take on residual value or usage risk. To provide an upside, additional securities and equity options are required. Although the Investor avoids usage risks, it does assume the counterparty risk of a start-up company, a common practice for venture debt firms. Like Bank 1’s offer, this offer can be viewed as a flexible loan rather than PaaS.

Strategic Investor: “SPV Owns the Asset” operating model. The Asset Producer and Investor each hold a 50 percent stake in the equity tranches of the SPV. The Asset Producer offers residual value and utilization guarantees to the SPV, reflecting a producer-driven PaaS offering. This approach allows the Investor to transfer most risks to a third party, as they do not consider themselves the natural risk owner.

FinTech: “Investor Owns the Asset” operating model. The Investor offers partially variable payments (up to 75 percent) linked to asset usage, which is comparable to a utilization guarantee from the Asset User. It

requires residual value guarantees from the Asset Producer. Since the Investor assumes part of the usage risk, it is selective about the industries and asset types financed. This model represents an investor-driven PaaS offering.

Conclusion: The PaaS financing market is emerging, with new risk-sharing solutions

Our analysis yields the following observations:

- Traditional banks typically avoid usage risks, which means they are not yet offering true pay-per-use/PaaS options.
- The most suitable parties to assume usage risk are Asset Users or producers, as they have the best understanding of the market and are responsible for business development.
- Although venture capital firms are willing to take on usage risk, they seek higher potential returns, making them less interested in PaaS investments.
- Some strategic investors, in collaboration with FinTechs, have started to take on partial usage risks, positioning themselves as pioneers in the industry.
- To effectively monitor and quantify usage risk and implement usage-based billing, internet-of-things solutions are necessary.

05

Operator Perspective

The Key Takeaways

- The question of operation is tied to the considerations behind regular outsourcing scenarios – strategic importance vs. operational contribution.
- One of the Asset Users, the Asset Producer, or a third-party manufacturing service provider can be imagined as operators for a PaaS asset.
- As the Asset Operator also requires a service margin, PaaS offerings with single assets solely focus on the original Asset User as the operator.
- In case of more complex process chains, opting for the Asset Producer or a third-party contractor is mainly driven by the desire to increase the overall efficiency.

Finally, the operation in a PaaS setting is of high importance. As demonstrated in previous chapters, there is no one-size-fits-all solution, and factors such as company size, production technology, strategic importance, and economics influence the design of a PaaS system. Given the transfer of ownership away from the Asset Producer and the concept of production sharing, addressing the structure of operations is the logical conclusion of our study. We can envision various scenarios, depending on the scope of assets (which can range from a single machine to an entire process chain) and the driving force behind a PaaS solution.

Which factors drive decisions around the operation of production assets?

It is important to first understand the rationale behind company decisions surrounding the operation of production assets, because “as-a-service” can be easily confused with classic outsourcing decisions. There are two primary dimensions to consider: strategic importance and contribution to operational performance.

- **Strategic importance** refers to how crucial a process or part is for the company’s objectives or final product. For example, a vehicle’s drivetrain can be considered system-critical and therefore strategically important for an OEM.
- **Contribution to operational performance** describes whether a process is essential for maintaining smooth operations and if it is truly necessary. An example would be vehicle windows, which are critical for a car to function and required to maintain the manufacturing flow.

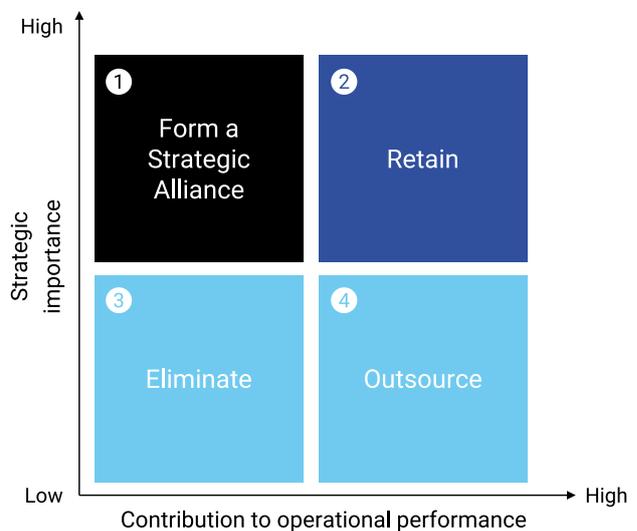
Mapping these two dimensions into quadrants results in four scenarios for a manufacturer (Exhibit 26):

- **Form a Strategic Alliance:** If a task or process is strategically important but has a low impact on operational performance, it makes sense to outsource it by forming a strategic partnership. An example would be partnering with a logistics expert to facilitate the supply chain for a manufacturing company.
- **Retain:** If a task or process is strategically important and highly impacts operational performance, a company must retain and maintain full control over it.

- **Eliminate:** If a task is neither strategically important nor has a significant impact on operational performance, a company should eliminate it.
- **Outsource:** If a task is not strategically important but highly impacts operational performance, a company should outsource it. An example would be spare part production, which is important for a manufacturer’s products but not strategic.

Exhibit 26:

What drives decisions around the operation of production assets?



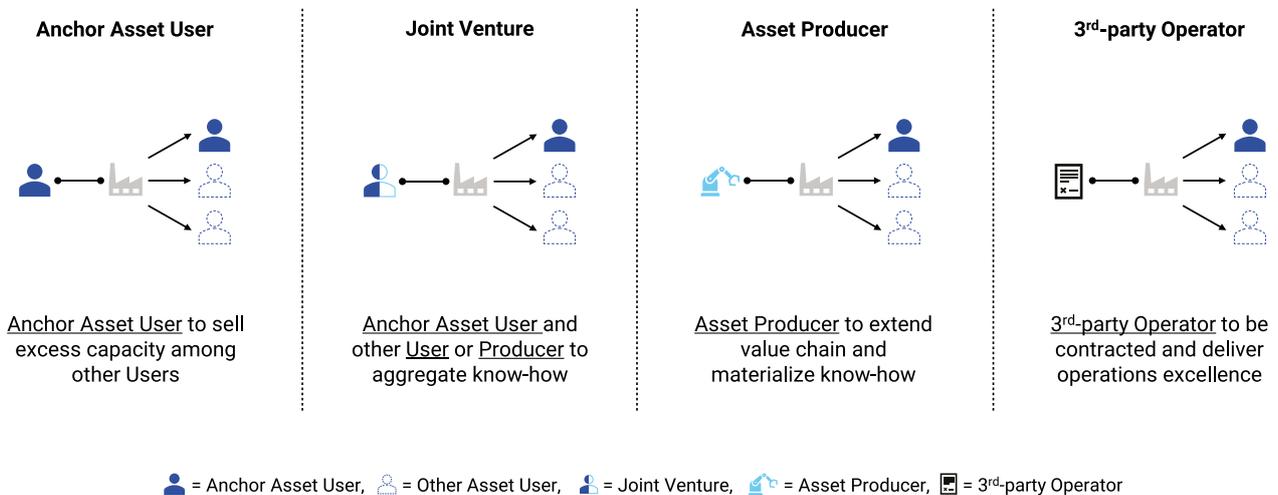
Source: P. Dornier, R. Ernst, M. Fender, P. Kouvelis, 1998, Global Operations and Logistics, John Wiley and Sons

Users have different options for operating PaaS production

Parties can use this analysis to structure a PaaS operation. Before looking at the different scenarios, it is crucial to note that PaaS models often revolve around an Anchor Asset User, who serves as the project’s cornerstone and initiates the process. In most Equipment as-a-service settings, this Anchor User is the sole user of the manufacturing asset, and there is no need to consider the question of operations. However, in a PaaS setting, the question becomes more complex.

Users have different options to operate PaaS production

Operation option space



There is still an Anchor User. But depending on the motivation for entering a PaaS business model, this user may be the sole user of a manufacturing asset or the starting point for attracting additional Asset Users. Considering this, there are four conceivable scenarios for operation (Exhibit 27):

Anchor Asset User: In this scenario, the Anchor User builds and operates production, then markets capacity to other companies. The primary motivation for this setting is to sell excess capacity and improve the asset's economics. For the Anchor User, this is often a strategically important process step with high operational value, making control essential. However, using the asset alone yields a negative return on investment, so PaaS may be the solution. An example is Al Seer Marine, which uses additive manufacturing for its yacht components and offers its excess capacity to produce for other companies.

Joint Venture: Here, the Anchor User partners with an Asset Producer to create a joint venture responsible for the assets' operation. This approach is driven by the desire to consolidate know-how along the entire value chain. The combined expertise of both players is expected to lead to significant performance or efficiency improvements. These partnerships are also formed to learn and further develop operational skills and asset understanding. An example is the Smart Press Shop, where Porsche and Schuler founded a joint venture responsible for operating the facility. The company has its own staff and can produce for other OEMs.

Asset Producer: One reason an Asset Producer might offer PaaS is to extend its value chain by operating its assets. From a user perspective, some industries believe that an Asset Producer, having engineered and assembled the assets, is best suited to achieve a performance uplift that ultimately benefits both parties. Since the user has a strategic interest, it enters a partnership with the Asset Producer rather than retaining the task, which can be considered a form of outsourcing. An example is the KUKA Toledo Production Operations (KTPO) in Toledo, Ohio, where KUKA operates the body-in-white facility for the Jeep Wrangler. However, interviewed Asset Producers made clear that transitioning towards operating their own assets is a complex endeavor. It necessitates, for instance, new staffing and legal clarifications, and could potentially lead to competition with their own customers. As such, an Asset Producer operating as-a-service provider might only be conceivable as a show-case or for niche solutions.

Third-Party Operator: Last, there is the option to use a Third-Party Operator focused on operational excellence. This company would be subcontracted, and the Asset User would formally outsource its operations. In this case, classic contract manufacturers, such as Valmet or Magna, would manage the operation.

Driven by technical complexity and the operational skills of all involved parties, respective scenarios are suitable for different situations

Looking at the four options, we clearly see that the operation decision is largely determined by the objectives of the Anchor Asset User, with technical complexity also a factor. At the same time, as for every decision in a business context, economic factors play an important role.

It is important to note that there is no universally correct approach. In every PaaS setting, the following factors must be considered for each potential stakeholder who could operate the assets: operations experience, expected performance uplift, conflict of interest, liability questions, aggregation of know-how, and financial attractiveness.

Generally, if the Asset User allows an external partner to operate the production, there will be less value-add in terms of a higher margin and the level of control. Additionally, integrating a Third-Party Operator with no strategic interest in the job will be the least attractive in terms of these dimensions. However, using a Third-Party Operator decreases the operations risk, because the Asset User does not need to manage the complexity of operations. In this case, an experienced Third-Party Operator specialized in such tasks provides the most secure option.

As mentioned earlier, an Anchor Asset User must carefully consider its objectives and the partners involved to determine how to structure the operation. If there is only one user, this question will not be as relevant, as an external Third-Party Operator is not necessary. Finally, it is essential to consider that all other Asset Users will view PaaS as a form of outsourcing or contract manufacturing.

06

Recommendations for Action

This study demonstrates that PaaS can offer substantial benefits for both Asset Producers and Asset Users. The prerequisites for success are an increase in utilization, such as through asset sharing, and an increased margin for Asset Producers via added services. Given these conditions, two fundamental questions must be resolved: who finances the equipment, and who operates it?

The inherent complexity, potentially coupled with the establishment of a production-sharing environment, is tremendous. Hence, most market players with existing offerings have identified strategic partners with complementary skills and experiences. Given that securing a reliable financing partner is crucial for PaaS to succeed, this approach is the most logical choice. This perspective was confirmed by the four interviewed managers with existing PaaS offerings. An alternative approach involves partnering with consulting-oriented players with robust project management skills and an established network for operational support. A wide range of players exists, focusing on either the digitization or the financial transformation layer.

Once a partner has been identified, a structured three-phase approach, as presented in Chapter 3 (Exhibit 19), can guide an efficient path towards establishing an offering. The evolution of existing PaaS offerings indicates that starting with a Proof-of-Concept (PoC) can provide a good indication of the market response. In collaboration with a pilot customer, companies can identify and test critical aspects of an offering. Notably, an equivalent number of offerings have exited the market as have expanded their scope following an initial trial.

Yet, the financial model presented in Chapter 2 and Chapter 3 has shown that offering industrial equipment via a pay-per-use format is often more costly than a standard financing. The consequence is that sales has to be effective in positioning the additional advantages such as e.g., flexibility or full-service arrangements. Likewise, this has also demonstrated that PaaS only works for specific parameters with regards to production technology, industries, and customer size. Especially, the existence of a secondary or resale market has a vast impact on the refinancing of such a business model and also limits the risk for the Asset Owner. Without the ability to resell used assets, the pressure to refinance an asset within the PaaS contract is a substantial hurdle for the Asset Investor.

At the same time, the interviews with representatives of existing pay-per-use or PaaS offerings showcase that if an Asset Producer follows a clear objective arising from a customer need and treats such a project as a long-term opportunity, there is a place for as-a-service models in the industrial equipment industry. Given the increasing complexity of the broader economic and political environment, the corresponding value in form of flexibility and customer centricity has a lot of potential increase – especially in Europe and North America.

The following summary takes the perspective of mechanical and plant engineering to summarize the essentials that must be discussed among decision makers as part of first initial considerations on Production as a Service.

What to consider:

- A.** PaaS is a different business model as it involves recurring revenue as opposed to one-time sales; thus, establishing such an initiative must be treated as a long-term project.
- B.** All successful PaaS offerings share that they follow a clear customer need or pain point that has been communicated by Asset Users in the past; most common drivers are Capex to Opex, higher flexibility, more services.
- C.** Due to the complexity of several components, it is essential to identify complementary partners that accelerate the path towards an established PaaS business; partners are mostly active for the financing and payment part.
- D.** As PaaS is a niche solution that does not work for every manufacturing technology and market segment, it is a good idea to work on a Minimum Viable Product (MVP) to test assumptions with an actual customer.

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I M P U L S -
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