TOOLKIT

CONFIGURING XAAS MODELS SHOULD BUILD ON FOUR CRITICAL DESIGN BLOCKS

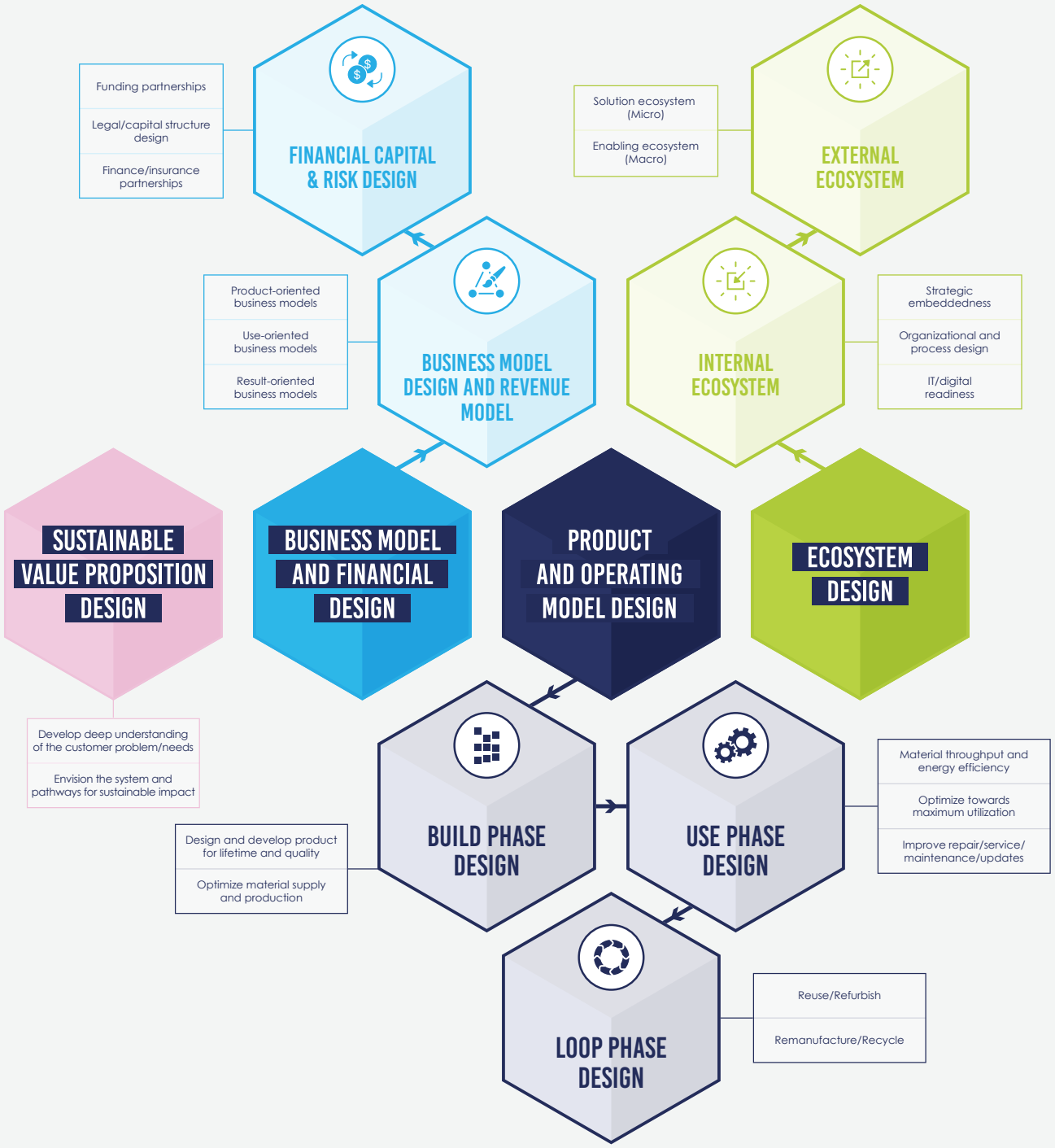
XaaS models can achieve significant impact in terms of resource productivity and decarbonization, thus should be designed for their full impact potential. In practice, many producers are stalled by the complexity of design choices and often there seems to be a lack of awareness about the decarbonization potential. The following chapter introduces a comprehensive toolkit for XaaS model configuration – with the aim to support decision-makers who aspire to design circular XaaS models that leverage both the economic and environmental potentials. Configuring a coherent XaaS model on this basis should address four critical design blocks (Exhibit 9). The pathway to take design choices depends on the individual organizational context.

- **Sustainable value proposition design (section 3.1.)** that inherently addresses specific customer needs while integrating a sustainable impact ambition as foundation for XaaS models.
- **Business models and financial design (section 3.2.)** that allow for different ownership configurations and pricing schemes as well as financial and risk design considerations.
- **Product and operating model design (section 3.3.)** for optimizing resource productivity by building on a holistic set of circularity levers.
- **Ecosystem design (section 3.4.)** with respect to the internal organizational and business solution level, as well as an external enabling system level.

3.1 SUSTAINABLE VALUE PROPOSITION DESIGN: COMBINE CUSTOMER NEEDS AND A SYSTEM IMPACT AMBITION AS THE FOUNDATION OF A XAAS STRATEGY

A sustainable value proposition is a promise concerning the economic, environmental and social benefits that a company's offer delivers to customers, the planet and society at large, considering both short-term profits and long-term sustainability.[39] Adapting the value proposition to customer needs and sustainability is a continuous and iterative design process. Companies need to ensure that the XaaS model is designed such that it represents an ideal problem solution fit and is grounded in the sustainable value proposition. For this, it must build on a deep understanding of customer needs (section 3.1.1.) and integrate a sustainable system vision (section 3.1.2.).

Four building blocks to configure XaaS models.



Source: SYSTEMIQ.

3.1.1 DEVELOP A DEEP UNDERSTANDING OF THE CUSTOMER'S PROBLEM AND UNDERLYING NEEDS

Designing an XaaS model should start with profoundly understanding the respective customers, the underlying problems and user needs (see Case box 2). For developing an XaaS model, a customer-problem-first approach is favourable above a technology-first or product-driven approach, which often takes a narrow perspective. Ideally, the ambition of XaaS models must be that the underlying human or societal need (e.g. housing, mobility, nutrition) or the customer problem is better solved by shifting from selling a product to turning that product into a product-service-bundle – which is then more effective and sustainable in terms of utility provision. The utility is what the customer buys and considers as intangible value, not the physical product.[40] In the end, customer utility counts and is the ultimate measure of customer value.

> A user-centred value proposition is critical for XaaS models. Product-service-bundles need to be closely tailored to underlying user needs. Beyond that, oftentimes the users are needed to enable systems to work in a circular way – they may for example need to return an item post use or share usage data.
>
> **Chris Grantham**
> Circular economy portfolio director at IDEO

Common types of customer needs include affordability, functionality, quality, reliability, low costs, transparency, accessibility, or controllability. Most of these customer needs work together to bring about a purchase decision.[42] There are various tools which can help to discover underlying needs that companies aim to address with service-oriented offerings (see Appendix B.1).

EXAMPLE 1

The basic need of a car might be mobility, getting passengers from A to B (without the need for ownership of the car that provides mobility whenever needed).[41]

EXAMPLE 2

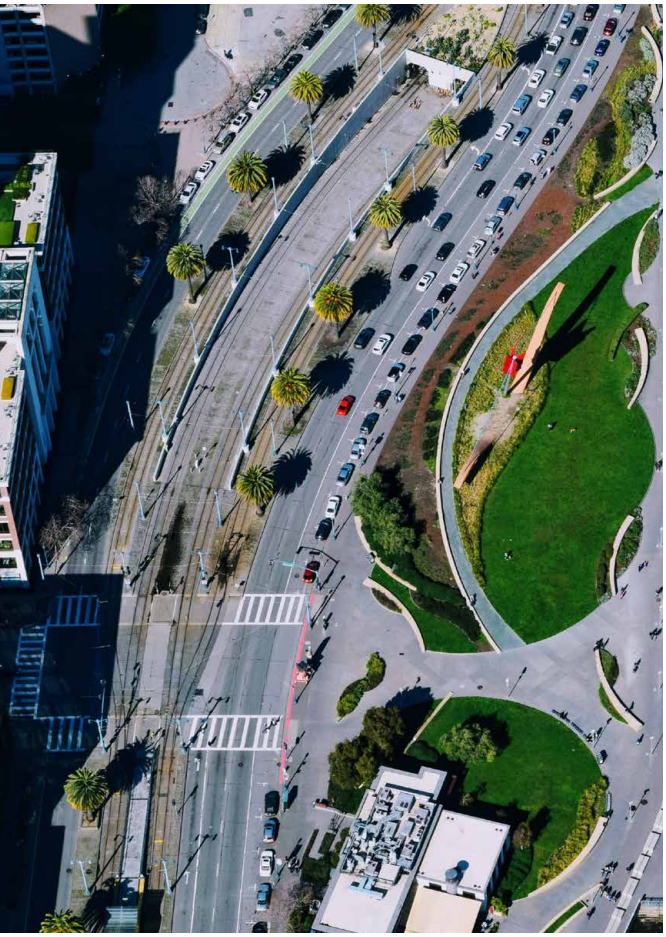
The basic need of clothes might be to express personality on different occasions without necessarily owning all the clothing items but having access to them.

EXAMPLE 3

In the case of housing and building products, the valued purpose might be protection and safety.

CASE BOX 2:
CWS – PROVIDING SYSTEMIC SOLUTIONS FOR HYGIENE AND WORKWEAR

By focusing on solving customer needs from a systemic perspective, CWS offers full-service solutions for hygiene/washroom and workwear. The Hygiene-as-a-Service model involves everything from equipment to operations and professional support services. The Workwear-as-a-Service model integrates product design strategies for durability, repair and professional washing services, as well as recycling partnerships. Products and services are part of a circular system: for example, textiles are cleaned in a resource-efficient way and can be reused extensively, thereby significantly increasing customer convenience.[43,44]



3.1.2 ENVISION PATHWAYS FOR SYSTEMIC IMPACT

Producers should assess their own environmental, social and governance (ESG)[iii] related footprint in the wider system they are active in. To discover systemic issues within a respective system, producers need to assess the sustainability impacts of their company and products throughout the value chain. This is often important to put the aspired XaaS model into perspective and create a fact base for optimizing environmental, economic, and social impacts. For example, on a product level, lifecycle assessments (LCAs) can be a way to discover the environmental impacts quantitatively and qualitatively along the product life and help to mitigate negative effects.[94,95] Next to LCAs companies can use circularity metrics on an organizational and product level to assess the extent to which circularity strategies (e.g. reduce, reuse, recycle) contribute to a decoupling from resource consumption. Material footprints, which assess the material input along a value chain, are particularly helpful.

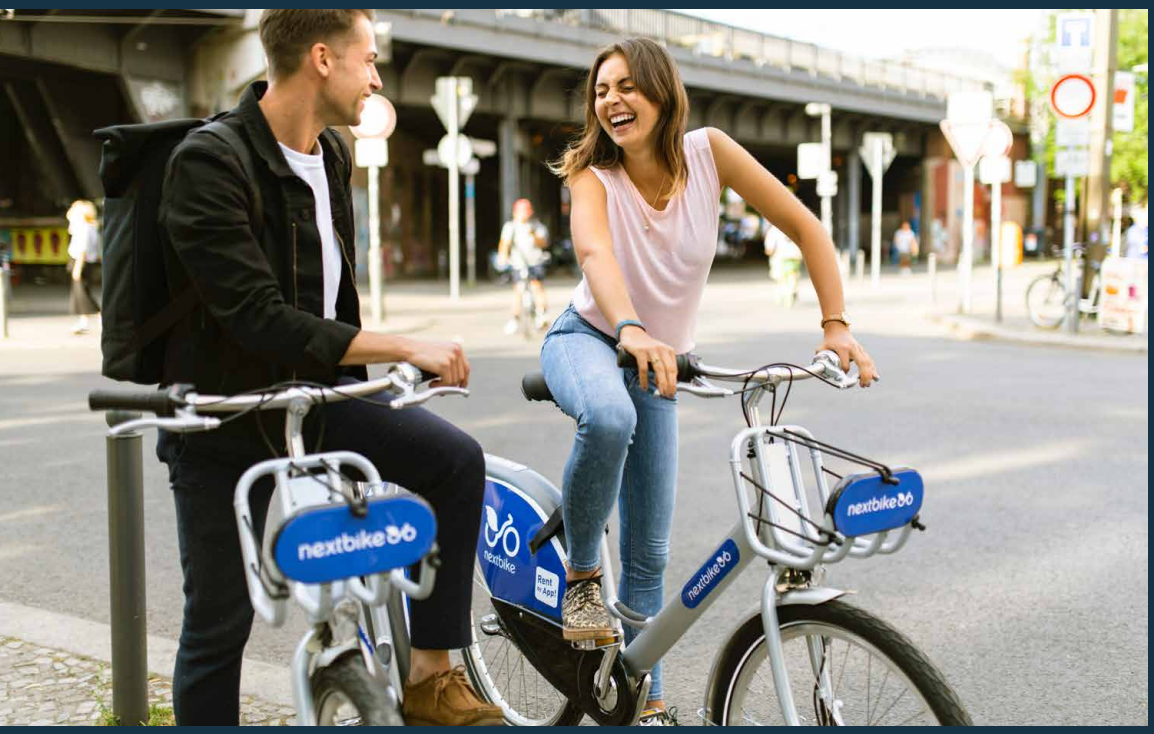
Each XaaS model operates in a specific system and producers need to understand their individual impact in the system related to ESG on a macro level. As described, besides addressing a fundamental customer problem and understanding underlying needs (in the narrow sense), it is important for producers to understand that their XaaS model is typically related to human societal needs in the wider sense. Hence, it operates in a wider system with impacts such as on CO_2 emissions, biodiversity, and other planetary boundaries, as well as social impacts such as on health or pollution. To successfully operate an XaaS model in a world where society

iii Environmental, social and (corporate) governance refers to the three pillars in measuring the sustainability impact of businesses. However, this publication focuses on the environmental and economic impacts of XaaS models.

must aim to achieve absolute resource decoupling, companies should envision how the system develops, what the critical systemic challenges are (e.g. in the mobility system, systemic issues would be low utilization, carbon emissions, or high primary resources demand) and how the XaaS offer interacts with the system (e.g. consider emerging rebound effects). When developing XaaS models, many producers purely focus on the product, which often results in models which don't work successfully in the wider system.

For producers, it is critical to explore the individual possibilities to improve the systemic impact. Based on the understanding of systemic issues, companies can decide which topics can be addressed (especially in the context of the XaaS model) and where specific activities could have the highest impact. For example, offering Batteries-as-a-Service requires IoT technology to control functionality of the batteries, hence the increased transparency in the value chain could in turn avoid environmentally harmful disposal at the end-of-life. Questions that need to be addressed are "what systemic challenges can the company influence, and where does the XaaS model with its focus on access, utility and performance really make a difference?"

Maximizing system impact also means mitigating unwanted systemic effects (e.g. rebound effects). This means evaluating consumer behaviour, especially during the use phase of XaaS models. On the one hand, this requires an integrated perspective on the product and operating model, especially regarding how different options for addressing customer needs can be compared to objectively evaluate and quantify their environmental performance. But perspective is also needed on how to comprehensively think about critical design choices to avoid direct negative effects within an XaaS model (e.g. if consumer behaviour leads to faster product attrition). In the age of digitalization, producers have opportunities to use tracking and tracing technologies to enable their consumers to use their products in a more environmentally friendly way. For example, carsharing providers can nudge more careful customer behaviour through telematics-driven incentives. On the other hand, a systemic lens is needed to circumvent undesirable rebound effects (see section 2.2.2). For example, such effects may be triggered by relative price changes and respective behavioural changes, hence producers should evaluate how pricing may induce environmental rebound effects and explore pathways to proactively mitigate these.



3.2 BUSINESS MODEL AND FINANCIAL DESIGN: EXPLORE XAAS BUSINESS MODEL ARCHETYPES AND RISK MITIGATION STRATEGIES

3.2.1 BUSINESS MODEL DESIGN: CONFIGURE A XAAS BUSINESS MODEL ORIENTATION

There are four main archetypes that guide XaaS business model design. Exhibit 10 introduces the four archetypes, which are either product-, use- or result-oriented. The fourth archetype includes sharing platforms.[iv] In practice, however, these models cannot always be clearly distinguished from each other and there are many different combinations. For example, there are product-oriented business models with linked subscription-based services. Companies may offer different business model orientations and payment schemes at the same time, depending on the market they are operating in.

A critical design choice is whether the XaaS provider still transfers product ownership or keeps the ownership (producer ownership). Transfer of ownership indicates a product-oriented XaaS model. Those XaaS models build on selling products but add extra services for substantial value creation. Some product-oriented XaaS models may even move into use-based value creation through services rather than actual product sales. Such services are part of the sales proposition and can include maintenance agreements, consumables subscriptions and take-back provisions. Service contracts are typically based on a use- or result-oriented business model. For example, maintenance agreements or delivery of consumables can be billed on a subscription basis. Take-back provisions are particularly suitable for service providers, which have a continuous demand for their own (obsolete) components (e.g. for remanufacturing new products, spare parts), want to control the secondary market, or want to secure supply of critical resources (see Case box 3).

CASE BOX 3: PHILIPS – CIRCULARITY AND TAKE-BACK SCHEMES

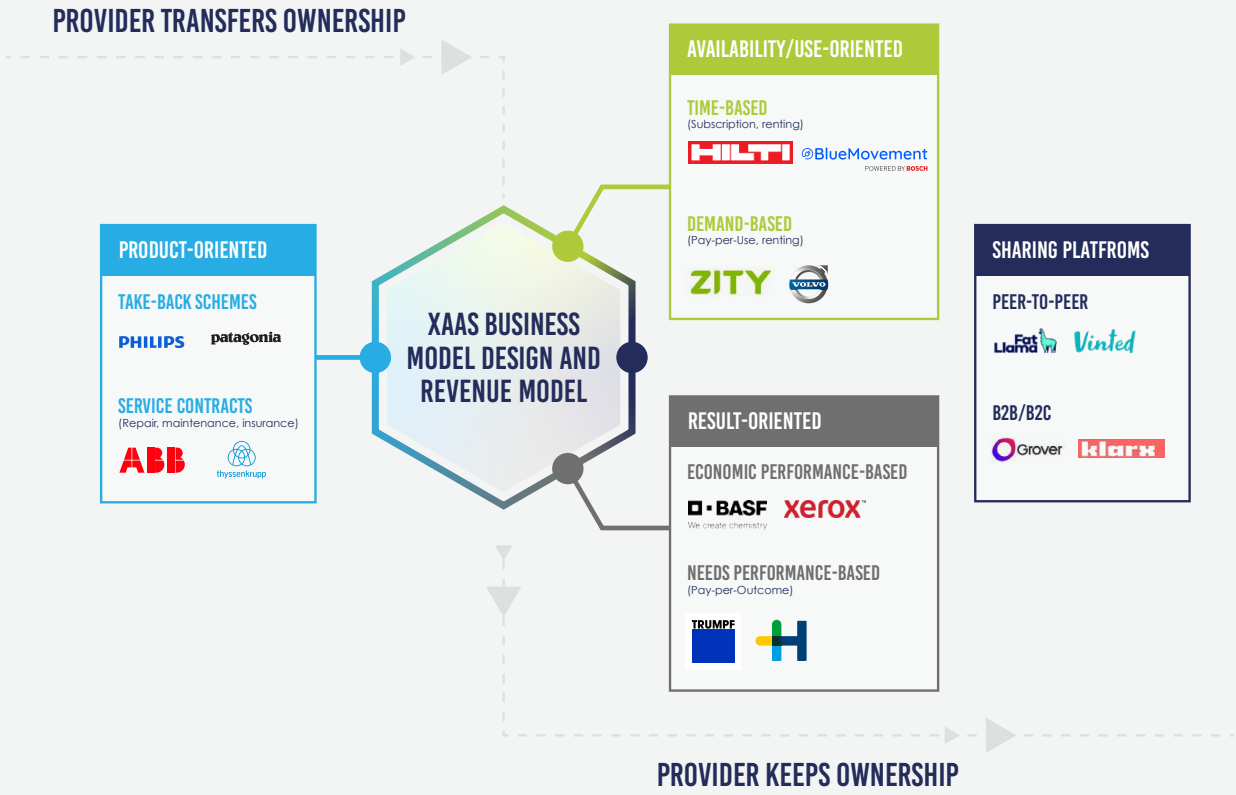
Philips is successfully applying various XaaS business models to operationalize the company's strategic objective of generating 25% of sales from circular products, services and solutions by 2025. To do so, Philips committed to take back all large medical equipment by applying product-oriented XaaS models. Typical equipment to be recycled or repurposed by Philips includes MRI and CT scanners. To execute the product-oriented business model, the company is collaborating with various partners across the globe.[45]

Keeping ownership as a XaaS provider indicates a use-oriented, result-oriented business model or an XaaS model based on sharing platforms. Assuming responsibility for the product over the use phase until the end-of-life can create an incentive to design products that are amenable to life extension and value retention processes (e.g. remanufacture, refurbishment, or repair). Producers

iv The four archetypes already served as a guiding structure for the XaaS landscape overview in Chapter 2.

EXHIBIT 10

Key business model configurations for XaaS models.



Source: SYSTEMIQ collation based on Tukker, A. (2015).

or XaaS model providers sell the access to utility, availability or function of products which may be shared with multiple users (e.g. through renting, sharing, pooling). Since recurring revenue streams replace one-time revenue recognition, financing XaaS models emerges as an important topic. In the B2C context, these models fulfil customer desires for maximum flexibility and convenience. In the B2B context, these models allow customers to focus on their core business, while the XaaS model ensures the performance of the product.

An important characteristic, from a financial perspective, is that these models enable customers to shift from capital intensive upfront investments (CapEx) to recurring operating expenses (OpEx) with a possibility for off-balance sheet accounting in a B2B context. Use-oriented and result-oriented models can reduce the overall TCO for customers. Only the access to and utility from using the product are remunerated instead of the entire product. This eliminates upfront investment costs (CapEx) and shifts these to the recurring operating expenses (OpEx). Hence, in a B2B context, capital-intensive investments and acquisition costs are shifted from the balance sheet to the P&L and reduced to the amount of access/utility provided. This provides opportunities for balance sheet improvements compared to other financing models such as leasing, since the introduction of IFRS 16 prevents leases from being accounted for off-balance sheet (see Info box 2 in Appendix B.2). At the same time, the CapEx to OpEx model increases cost transparency and planning certainty as customers shift to pay-as-you-earn models.

Companies adopting use-oriented business models typically offer a product-service-bundle (including added services) through an availability/use-based model and payment scheme. Added services often include repair, insurance (e.g. against theft), breakdown replacements, transport services or collection of products at the end-of-life. In use-oriented XaaS models, the provider can decide between either a fixed contract duration (e.g. subscription model), or usage-based pricings (e.g. Pay-per-Use). Several companies offer both models to their customers. For example, the machine tool producer Hilti offers both a fleet model for tool lease (see Case box 4) and a peak demand pool for tools based on Pay-per-Use.

CASE BOX 4:
HILTI – FLEET MANAGEMENT

Hilti has established a circular economy programme with the goal to lead the construction industry. The company provides construction tools in a service-based fleet management solution as a one-stop service to customers (time-oriented XaaS model). For a fixed monthly fee, a customized fleet of power tools can be accessed. Complementary services are provided: inventory management, repair and replacement, insurance and access to new models after the initial term has expired. The model reduces downtime and increases flexibility. Additional tools can be ordered to compensate for peak times (use-oriented XaaS model) while effectively reducing the investment risk for the customer.[46]

Companies adopting result-oriented business models offer the product-service-bundle based on results/performance or output of a product (e.g. parts produced by a machine). Offering products in result-oriented business models provides maximum flexibility for customers and fundamentally aligns incentives between XaaS providers and their customers (see Case box 5). According to Walter Stahel, the real difference is between service offerings that guarantee the performance of the service – and those that do not. Performance guarantee equals liability. Focusing on a guaranteed outcome is the most systemic solution in terms of value creation.[47] In order for this model to be successful, producers must be able to measure the performance or output that the customer receives precisely in advance. Therefore, producers should closely collaborate with their customers to assess how well the model is accepted and agree on how to determine the value and overcome emerging uncertainties (e.g. in terms of ownership costs, product utilization and contract terms). Value-calculation tools and TCO analyses with pooled data from several customers are key tools to determine the value of result-oriented business models.[48] Academics argue that result-oriented XaaS models have the greatest potential for the circular economy, but also require the most radical change of the business model. Therefore, to date, these lack widespread adoption. Compared to use-oriented XaaS models, producers have the built-in business incentive to use fewer products (dematerialize) or use refurbished/remanufactured products to keep costs low while delivering the agreed outcome.[49] In case of higher uncertainty on how to measure or determine the outcome/value, use-oriented business models based on other factors (e.g. use and time) may be more suitable. But technological innovation in terms of IoT sensors and data analytics makes result-oriented models more and more feasible and attractive.

Sharing platforms are an additional XaaS business model type, typically representing a platform-model that goes beyond the use-/result-oriented models offered by single producers/providers and typically offering multiple products (e.g. beyond single brands). The models are increasingly adopted by platform providers (often start-ups), not only by producers (see Case box 6). Sharing platforms mainly facilitate the sharing of overcapacity or underutilization; they thereby increase productivity through efficient matchmaking of supply and demand and often allow customers to choose among different brands. After models such as AirBnB in the building sector and Uber in the mobility sector have experienced a strong upswing in recent years, they are also becoming increasingly popular in the manufacturing sector (e.g. Grover, Whirli, unown). The business model appears to resonate not only with customers but also with investors: since its beginnings in 2014 the sharing economy market is expected to grow twentyfold by 2025 (335 billion USD).[51] As sharing platforms have so far often not been offered by

CASE BOX 5:
KAESER KOMPRESSOREN – COMPRESSED AIR-AS-A-SERVICE

Kaeser Kompressoren offers compressed air in a result-oriented business model. In the SIGMA AIR UTILITY model, customers only pay for the compressed air provided via the equipment that is built, installed, and operated by Kaeser (e.g. pricing per cubic metre of compressed air). A global service network and digital services ensure reliable availability of compressed air with highest possible energy efficiency and continuous optimization of the system. Kaeser not only cover operation and maintenance, but also the responsibility for safe and legally and regulatory compliant operation.[50]

CASE BOX 6:
GROVER – SHARING PLATFORM FOR COLLABORATIVE CONSUMPTION

Grover is a sharing platform for technological devices such as notebooks and TVs replacing traditional ownership models with flexible subscription services. After the subscription term, products are returned and offered again. On average, products are recirculated four to five times, thus increasing the utilization of unused devices. Reuse and repair services effectively extend the life of the equipment. Grover aims to enable large retailers and OEMs to adapt their business model by integrating consumer-electronics providers on the platform.[52,53] With plans to triple subscriptions by the end of 2021, Grover has recently closed a new funding round that will enable it to meet the growing demand for rental services.[54]

the producers themselves, the question naturally arises as to what extent platform providers can integrate sustainability aspects – beyond the higher utilization rates – into their product portfolio composition or even the product design and manufacturing processes of suppliers. However, due to their increasing market power, it is now possible for platform providers to exert greater pressure on producers in terms of sustainability. Last year, for example, Uber announced that 100% of rides will take place in electric vehicles by 2030 in the US, Canada and Europe, and by 2040 for the rest of the world. Depending on the increasing market power of Uber, these strategic goals can greatly increase the demands on producers for more sustainably designed cars, in this case battery electric vehicles (BEV). Sharing platforms which help to maximize utilization could benefit producers whose products and assets have a low utilization or ownership rate.

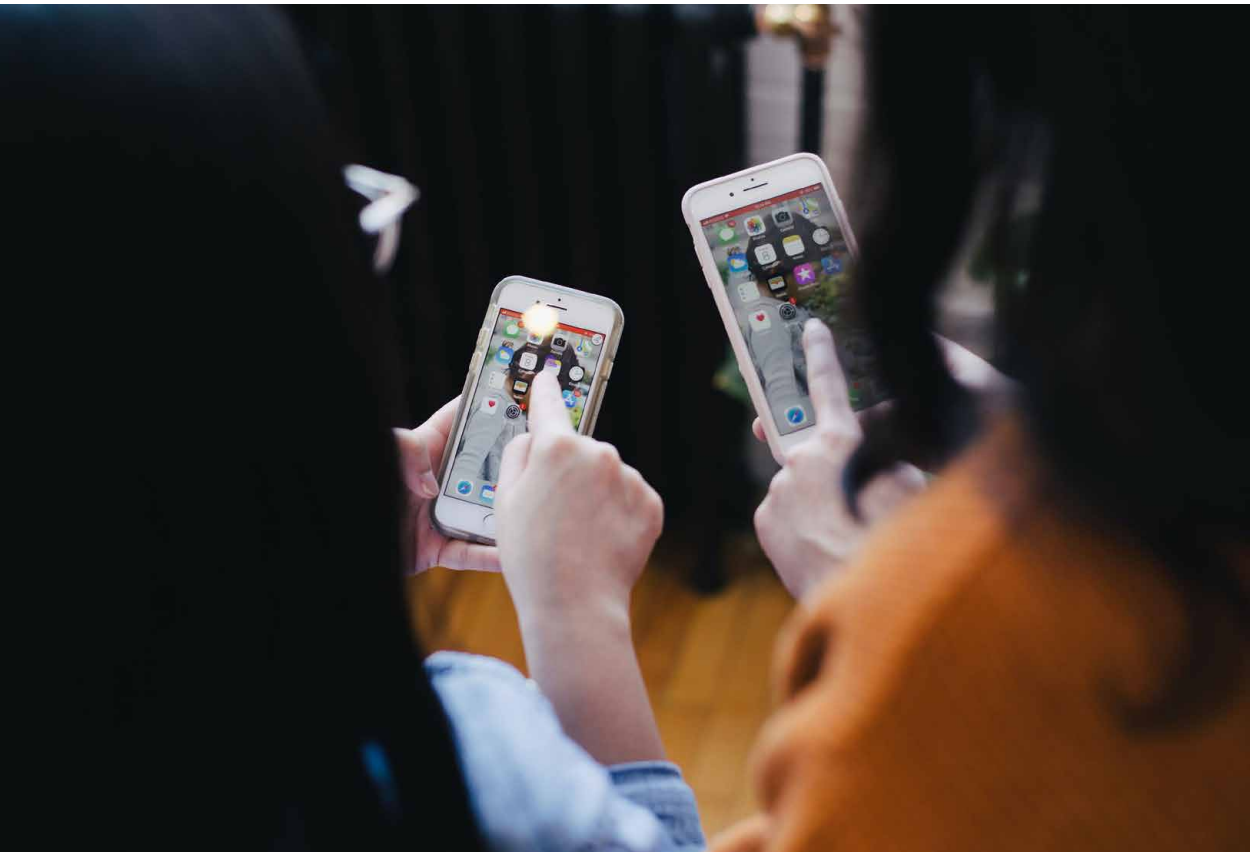
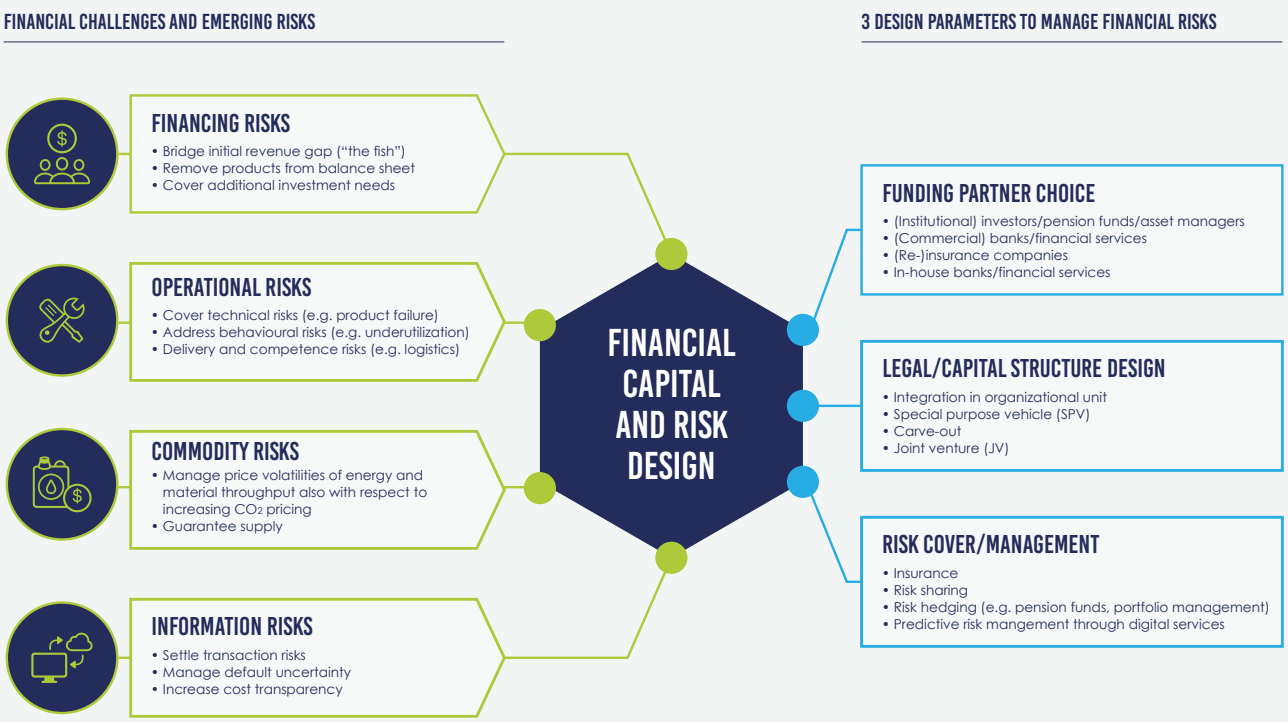


EXHIBIT 11

Managing financial challenges and risks is a critical design choice for XaaS models.



Source: SYSTEMIQ collation.

3.3.1 DESIGN THE FINANCIAL SET-UP AND MANAGE RELATED RISKS

Four types of financial challenges and risks must be considered in XaaS models and can be shared with other partners or mitigated through risk management strategies. These include financing risks, operational risks (technical, behavioural, delivery risks), commodity risks and information risks (see Exhibit 11). For example, financing risks refer to capital risks associated with funding/ investment requirements and risks related to bridging initial revenue gaps (see Info box 1). Not all business models are equally affected by these challenges and risk types to the same degree (e.g. product-oriented business models might not be affected through financing risks as products are still being sold to customers).

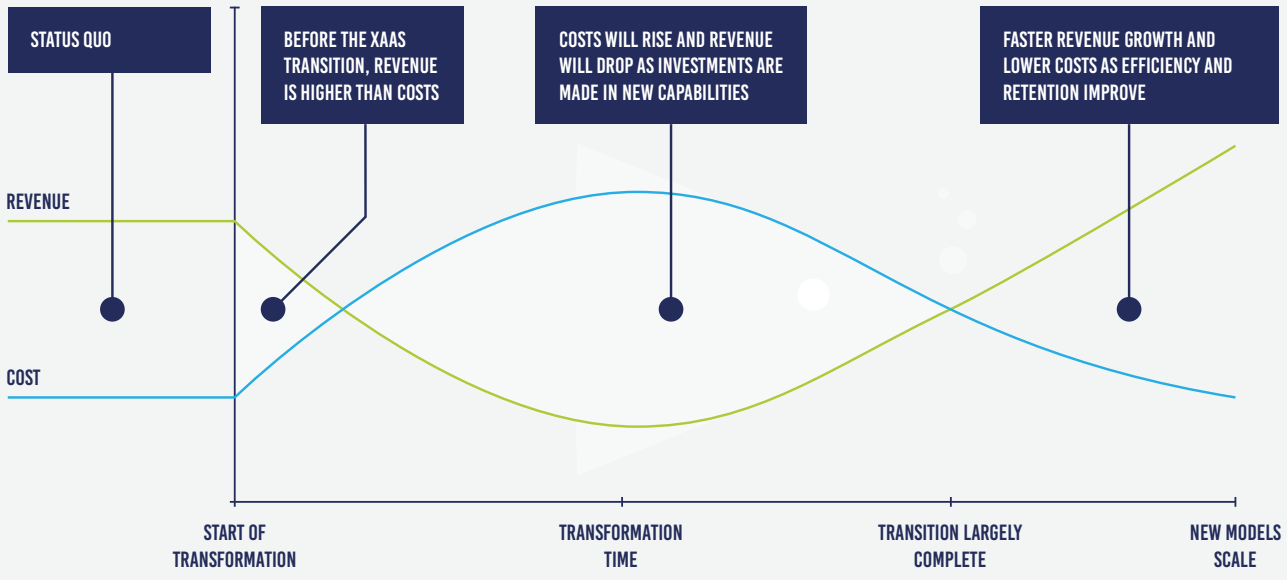
INFO BOX 1:

THE MOVE TOWARDS XAAS MODELS (E.G. USE- AND RESULT-ORIENTED MODELS) IS ECONOMICALLY CHALLENGING FOR BUSINESSES, ESPECIALLY IN THE FIRST 5-10 YEARS.

Producers or XaaS model providers need to plan for an interim period when costs will be higher and revenues lower before the financials find their new trajectory, called "swallowing the fish" (see Exhibit 12). The term refers to the shift from technology (products) as an asset to technology (products)-as-a-Service. During this time, initial revenues drop as upfront contracts are replaced by smaller but regular income streams. Simultaneously, operational costs rise (e.g. in customer services, organizational change) to establish and support the XaaS offering. When the transition gains momentum and scale, regular revenue streams overtake costs which continue to fall (as scaling effects and delivery increase).

EXHIBIT 12

XaaS transformations typically need to bridge a critical transition phase from a financial and risk perspective.



Source: Technology Services Industry Association (TSIA) (2013).

Pathways to mitigate these challenges are dependent on the respective context. For example, producers may adjust their pricing model and charge a premium, which is particularly interesting for product-bundles in use-oriented business models (e.g. tool fleets) that can significantly generate value through the added services beyond the original product. Other examples include partnerships with financial institutions (e.g. banks, insurances).

As more and more XaaS models emerge across sectors, the financial and risk management ecosystem tailors solutions as well, paving the way for the XaaS industry revolution. Related to the above-described developments, there are three design choices to manage the emerging risk profile of XaaS providers and ecosystem partners (see Exhibit 11).

(a) **Collaborating with funding partners can mitigate financing risks – a major challenge for the XaaS implementation, especially for capital-intense goods and in stock market-driven organizations**. The investment climate increasingly demands assets that enable decarbonization. Asset managers committed to sustainable finance seek new investment opportunities to diversify their portfolios and look at XaaS as a new asset class. Banks, (re-)insurance companies, institutional investors or venture capital investors have the ability to provide funding and risk coverage. In some cases, selling the assets (including risk transfer) to the financing partner secures revenue/liquidity for the XaaS provider (Case boxes 7-8). This seems to be especially relevant for use- and result-oriented models. If the financing partner is from within the same organization (e.g. internal bank), aligned interests for use-phase optimization exist. If it is external, profit-sharing mechanisms and participatory rights enable the producer to maintain control over the use and loop phase, a crucial aspect of sustainable XaaS models.

(b) **Designing legal and capital structures to alleviate financial and operational risks can follow different routes.** One option is the set-up of an intraorganizational unit within an established organization (e.g. departmental set-up or internal business building). This can help to leverage benefits from the parent company's brand, capabilities, and financing power. Another

CASE BOX 7:
BNP PARIBAS LEASING SOLUTIONS – A FINANCIAL PARTNER TO REALIZE XAAS MODELS

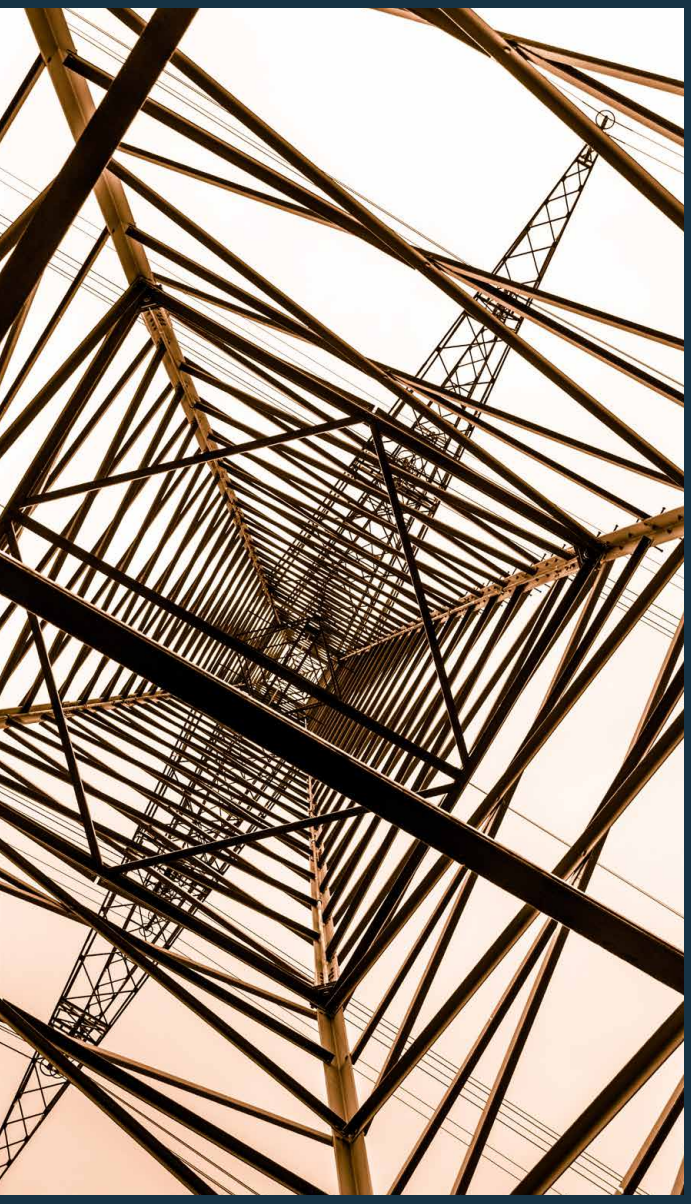
The subsidiary of BNP Paribas offers rental and financing solutions that promote a shift from an ownership to an access economy for apparatus such as medical equipment, construction equipment, utility and industrial vehicles. The company buys the equipment from the manufacturer on behalf of the customer in exchange for a monthly rent fee. Full-service leasing offers include repair, maintenance and spare parts services. At the end of a contract, the equipment is rented out again, promoting the reuse of unneeded assets.[55]

CASE BOX 8:
INTESA SANPAOLO RENT FORYOU – OFFERING OPERATIONAL RENTAL OF CAPITAL GOODS

With its services, the Intesa Sanpaolo Group promotes the transition towards a circular economy by providing financial support for investments to redesign the industrial system. Since its launch in 2018, the disbursements provided by its circular economy credit facility amounted to 2.2 billion EUR.[56] Intesa Sanpaolo Rent Foryou, a company of the Intesa Sanpaolo Group, supports the uptake of XaaS models by offering operational rental of capital goods for producers and companies that prefer access to goods instead of ownership. With its offerings, it aims to focus on the needs of producers and customers by maximizing the value of goods and rental contracts.[57]

option is to create new standalone entities (e.g. for start-ups, or carve-outs), to ensure the highest degree of flexibility. This can also take the form of special purpose vehicles (SPV), a ringfenced investment opportunity for a consortium of operating XaaS partners. Producers also have the option to form a joint venture (JV) with their customers and potentially other partners.

(c) **Beyond that, there are further approaches for managing and covering specific operational risks.** First, depending on the specific risk-types, an insurance partner can underpin the XaaS model. When printing company Xerox and the machinery and equipment company TRUMPF launched their first XaaS models, for example, they joined forces with reinsurance companies.[58] Second, the contractual design of formalized partnerships with customers and other support companies can be important to limit operational risks (e.g. extended service periods, downtime agreements). Third, contractual arrangements between producer and buyer can hedge commodity risks (e.g. price fluctuations of commodities, scenario-based limits). Fourth, digital services help XaaS model providers and partners to better predict occurring risks (e.g. performance transparency, pre-emptive maintenance).



CASE BOX 9:
SIEMENS SMART INFRASTRUCTURE – ENERGY EFFICIENCY-AS-A-SERVICE

Siemens Smart Infrastructure (SI) offers a range of result-oriented business and financial models for energy efficiency projects such as pay-as-you-save and performance guarantees to Energy efficiency-as-a-Service (EEaaS). The value propositions of such models include minimizing risks (project and execution, financing and performance), eliminating upfront capital expenditure and shifting CapEx to OpEx accordingly as a balance sheet neutral solution. However, all these models differ in risk and ownership transfer. For EEaaS models, Siemens SI assumes full producer responsibility: Siemens bears the financing and operating risk and retains ownership. In an extension of the model, namely Energy-as-a-Service contracts, the customer is compensating for the delivered energy and does not have to bear any upfront costs. Whereas Siemens SI is providing the technical expertise, Siemens Financial Services (in-house bank) is providing the necessary financing.[59]

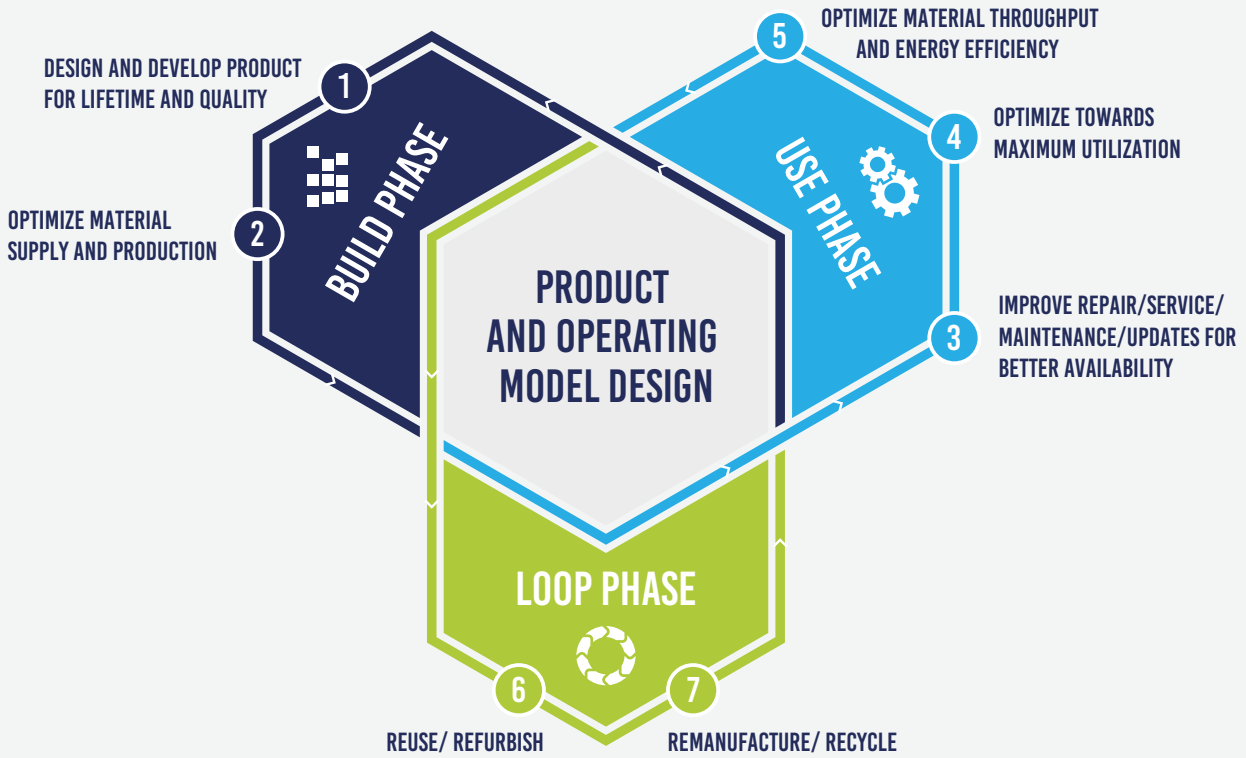
3.3 PRODUCT AND OPERATING MODEL DESIGN: OPTIMIZE FOR TCO AND ENVIRONMENTAL BENEFITS

XaaS models can be designed to achieve sustainability effects while offering benefits to customers in terms of TCO optimization – provided that the product and operating model is designed in line with circularity principles (Exhibit 13). In other words, unlocking sustainability effects and decarbonizing the product and its use means that a circular product and operating model design needs to be implemented in the XaaS model. The configuration of the business and financial model influences all lifecycle stages of a product. For example, producer ownership and the associated internalization of use and loop phase costs incentivize producers to consider these phases in the design of the product.

Academic research confirms that XaaS models can contribute to achieving dematerialization and decarbonization of industrial production systems – under the condition that circularity levers reinforce resource and energy efficiency.[49,60] The specific configuration of XaaS models along a set of key circularity levers is critical. Exhibit 13 highlights that XaaS models should optimize the entire lifecycle of a product which consists of (a) **the build phase** (encompassing the design stage and production of the product, including the materials and resources required), (b) **the use phase** (the operative stage of the product-service-bundle in its use by a customer), as well as (c) **the loop phase** (the stage of the product after its end-of-use or end-of-life, which

EXHIBIT 13

Seven circularity levers address all three lifecycle phases of the product.



Source: SYSTEMIQ.

entails that it is either reused or the materials are recovered). The three lifecycle phases embed a set of seven interdependent circularity levers that can lead to positive environmental impacts and TCO improvements at the same time.

a) **In the build phase, product lifecycle effectiveness is more strongly considered.** Retained ownership in particular, but also take-back obligations, shift the perspective towards seeing products as revenue-generating assets (for as long as possible) and internalizing end-of-life considerations. Two levers address this effect:

Lever 1: design and develop products for lifetime and quality. The design phase is critical in determining the lifecycle impact of products: over 80% of the lifecycle environmental impact is determined in the design stage.[61] Offering XaaS models increases incentives to design for lifecycle productivity. Accordingly, producers can opt to design for durability, choosing materials which are potentially more costly but last longer, reducing exchange and wear-off of parts and components – making the asset a revenue-generating entity over an extended lifetime, eventually resulting in better economic effects for both the XaaS provider and customer. For producers, the monetary boundaries of their customers may be less directly limiting of some product design choices (e.g. more durable materials, use phase improving technology). Product design in general is typically less driven by cost optimization than by quality optimization. Producers can design for modularity which facilitates the replacement of defective parts and maintenance. Since end-of-life treatments such as dismantling and recycling are the responsibility of XaaS model providers (or respective partners), they have incentives to improve design for disassembly, refurbishment or recycling. Beyond that, producers should aim to design for connectivity to increase uptime/lifetime (e.g. through predictive or preventive maintenance measures). Using sensors and data analytics, product performance can be measured, helping to create feedback loops for the product design to meet new requirements.

Lever 2: optimize material supply and production. Designing XaaS models towards decarbonization involves sustainable material choices and resource productivity in production. This particularly relates to the quality of the materials but also the sourcing according to sustainability standards throughout the value chain. XaaS models can strengthen integration in the value chain and often require stronger collaboration with other partners in the ecosystem, such as end-of-use/life managers and material providers, ensuring better access to recycled or other low-carbon materials (e.g. green steel). For example, frontrunners in the motor vehicle industry recognize the environmental and economic benefits and start to act: BMW recently introduced a "secondary first"

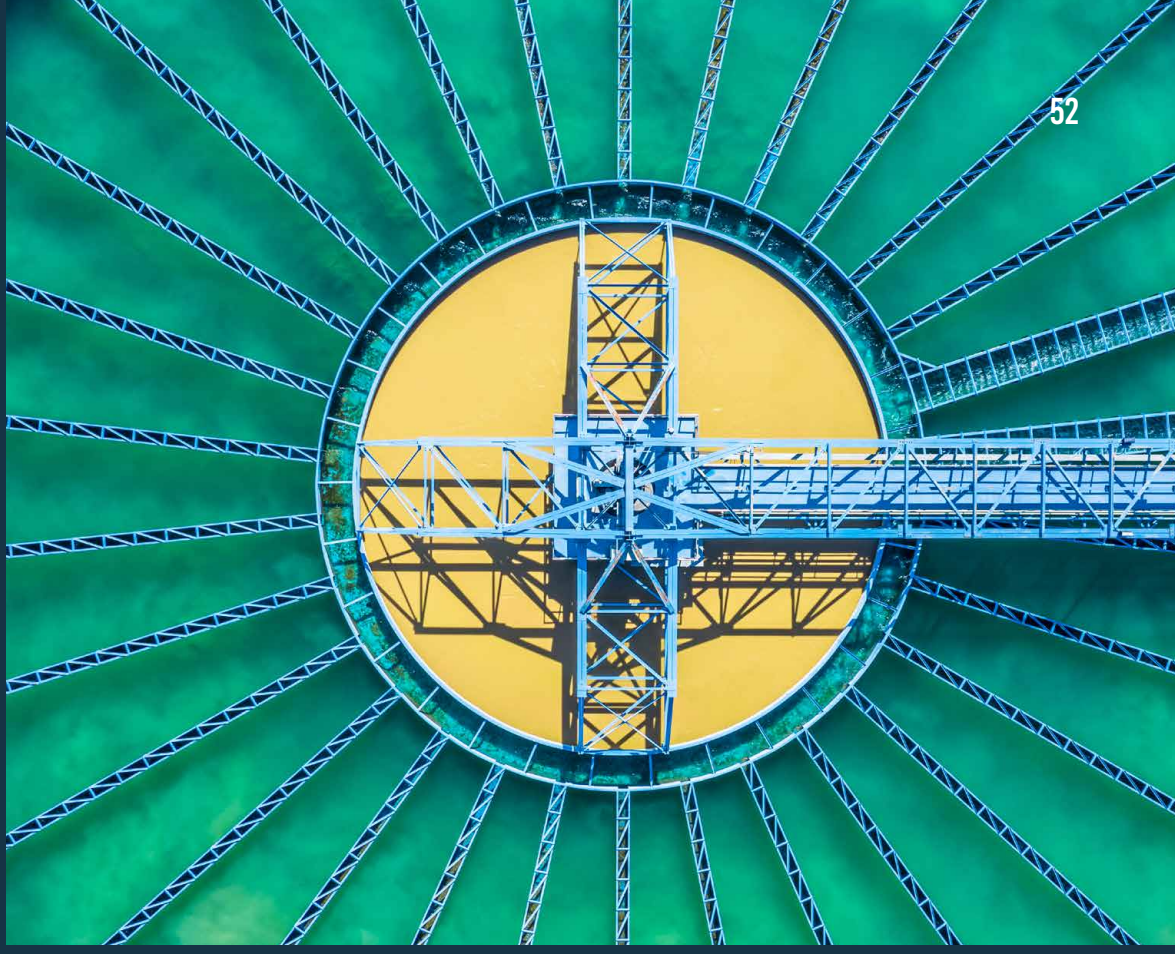
policy.[62] XaaS models are particularly relevant in that context as end-of-life control over the car can accelerate reverse material flows and the creation of closed loop systems (e.g. reintroducing recycled materials as secondary inputs). This also applies to waste waste from a company's own production, which can be introduced into the emerging material recovery networks. Technology can support the purchase of low-carbon or recycled materials/components with the help of traceability tools (e.g. blockchain-based), platforms (e.g. for recycled materials) or IoT technologies (e.g. test and assess used products with sensors and data analytics).

b) **In the use phase, XaaS providers can significantly influence resource productivity.** This builds on three levers:

Lever 3: improve repair/maintenance/servicing/updates. Since the producer or XaaS model provider often has more and deeper knowledge about the product than the customer, this can significantly improve service and operational support solutions. Customized XaaS models (e.g. result-oriented models) aim to increase the productivity of products (i.e. reduce downtimes and associated costs), whereby improved repair-maintenance systems are important to achieve uptime improvements with corresponding positive TCO effects. Smart usage with sensors, IoT, data analytics, and integration with ERP and MES systems can enable continuous monitoring of the product status or usage. This allows predictive or preventive maintenance schemes to be implemented, technical progress to be integrated more quickly (e.g. over-the-air updates or upgrades), or trainings to be tailored (e.g. advanced machine handling).

Lever 4: optimize towards maximum utilization. XaaS models typically democratize consumption and can enable product access for more customers than traditional models (e.g. sequentially or at the same time). Thus, the utilization of products can be massively increased. Maximizing utilization spreads the build-phase emissions, material resource requirements and costs of an asset over "more utility" provided (e.g. the passenger kilometres provided by a car). Often platform-based XaaS models can increase utilization through linking with digital marketplaces, user platforms or social networks. Use-phase process optimizations through monitoring, maintenance and training can result in increased uptime and operative functionality. Digital technologies can facilitate a higher utilization (e.g. machine learning applications and data analytics can improve the product effectiveness in the use phase).

Lever 5: material throughput and energy efficiency can be improved. The internalization of use-phase costs incentivizes producers to be as resource-efficient as possible in terms of utility provision. In XaaS models, being competitive does not depend on the build cost, but on the entire lifecycle cost and service quality. If energy and resource consumption in the use phase are internalized as costs for the producers, investing in more use-phase efficiency becomes viable as it improves the profit margin in the long run. This is especially relevant for products with a high energy consumption (e.g. electricity) or material intensity in the use phase (e.g. in the case of machinery, the material flow related to production processes on the machines), which can be influenced by the XaaS provider. The strong service orientation of XaaS models improves the quality of the product's operation and strengthens the customer relationship, ensuring aligned interests between producer/service provider and customer to optimize the use phase of a product continuously. Improving resource efficiency has a positive impact on both environmental and economic



outcomes. Again, technology can further drive material throughput and energy efficiency (e.g. digital twins can optimize product use and associated energy consumption by tracking operations and simulating outcomes).

c) **In the loop phase, XaaS models create incentives for producers to take responsibility for an asset at the end-of-a-use phase or end-of-life, enabling them to steer further use cycles of a product, reuse components or even manage closed material loops.** Two circularity levers address this:

Lever 6: reuse/refurbish. The extended responsibility for assets leads to increased reuse of products (e.g. through sequential use phases, second-life, resale) to keep and restore embedded value. In addition, especially when based on a modular design, products can be refurbished by exchanging worn-off parts or replacing more technologically advanced (and energy-efficient) core components. Hence, resource flows and cycles are slowed and narrowed. This decreases the TCO because costly virgin material and energy inputs are prevented. Since the XaaS solution ecosystem enables a closer partnership of actors along the value chain, reuse/refurbishment activities can be better coordinated.

Lever 7: remanufacture/recycle. Retaining control over the asset and embedded materials until the end-of-life increases the potential for material recovery. This entails remanufacturing practices, where components or parts are reused to produce new products. In addition, XaaS systems can play an important role to create closed loop material systems and recycling streams at high-quality (e.g. currently in the automotive sector, vehicles are mostly downcycled and value is lost). Accordingly, this can increase recycling rates and allows the capture of the actual value embedded in materials at end of use/life. This can be further reinforced through ecosystem effects from a deepened collaboration with complementors along value chains (e.g. material recovery partners) and technologies (e.g. digital product passports providing lifecycle information for appropriate end-of-life treatment).

What is the Cradle to Cradle (C2C) philosophy?

Definition: Cradle to Cradle® is a design concept which is inspired by nature. It describes the safe and potentially infinite circulation of materials and nutrients in cycles. The aim is not only to minimize negative influences but also to create a positive ecological footprint. As a result, products, processes, buildings, and cities will emerge which are safe for humans, healthy for the environment and successful for business.

Principle 1: Nutrients remain nutrients

- All constituents are chemically harmless and recyclable. Waste as we know it today and which is generated according to the pre-existing take-make-waste model will no longer exist, only useful nutrients.

Principle 2: Use of renewable energy

- The creation of products and systems is powered by renewable energy of the sun in many ways. Wind power, hydroelectric power, geothermal energy and biomass are further sources of renewable energy.

Principle 3: Support diversity

- Natural systems work and thrive through their complexity; i.e. nature promotes an almost infinite variety of designs, making systems flexible while at the same time resilient. When applying this principle to our economic and value system, biological, cultural, social and conceptual diversity is promoted, and context-specific solutions are favoured.

Which companies have adopted the C2C approach?

BRANDS FASHION: Apparel collection for the biological cycle and product-as-a-service

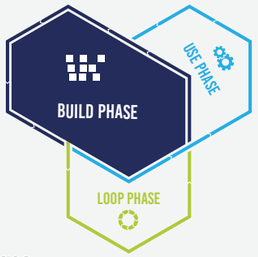
- 100% compatibility for humans and nature; no toxic substances leach from textile
- Produced with renewable energy
- Biodegradable fibres, sewing thread and printing paste
- Take-back and recycling possible due to already integrated service system of workwear in the B2B sector
- In the event of system leakage, no littering of environment due to biodegradability

NOVO-TECH: Floorboards for the technical cycle and product-as-a-service

- Wood polymer composite boards designed for a use-time of up to 30 years
- Ingredients fully defined and positively assessed
- Take-back after use-time; fully recyclable: old boards serve to 100% as input for new boards
- Produced with renewable energy
- Transfer of usage rights possible and encouraged by Novo-Tech

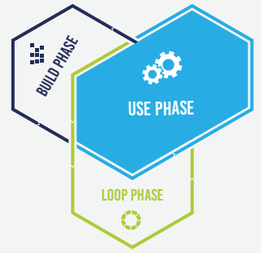
How are the C2C principles implemented along the key value levers?

From a Cradle to Cradle perspective, build phase, use phase and loop phase are interrelated and should be thoroughly considered during the design process. Loop scenarios are constructed either for the biological cycle (consumption products, e.g. cleaning products, natural fibres, degradable packaging) or the technical cycle (service products, e.g. flooring, electronics, furniture).



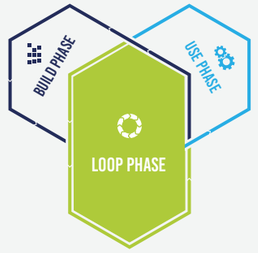
Build phase

- C2C works with a positive material definition (contrary to the common "free from" approach). Inputs for the manufacturing of a product are known down to the molecular level regarding their ingredients and evaluated for their toxicological and circularity performance. Only ingredients with good performance are chosen.
- As the manufacturer usually does not have access to the molecular material information, a material trustee steps in, receives the recipe from the supply chain, and delivers only the C2C assessment to the manufacturer. This way, both confidentiality and C2C eligibility are ensured.
- Not only should the products be designed for regeneration, the energy used during the production process should be regenerative as well. Therefore, C2C products must be produced with rapidly renewable energy.
- Designers and product developers need to ensure that products are made without problematic substances. In a C2C product, the selected materials are safe for humans (no toxicity issues) and do not impede the cyclability in the loop phase.
- Already in the build phase, material regeneration is considered and logistics for collection and recycling are set up.
- Applying the Cradle to Cradle principles in the design stage ensures safer, more sustainable products made for the circular economy.



Use phase

- In the use phase, material information and material value of C2C products is maintained owing to the positive material definition. With this, perpetual cycles of use and reuse are made possible.
- As all ingredients are known and positively evaluated, no toxicity emerges from C2C products, making it safe for humans and the environment.



Loop phase

- Since it was considered in the build phase of the C2C products, the technical systems for the collection and recycling of materials are in place.
- As envisaged and carefully incorporated in the product design, the product has 100% recyclability in the biological or technical cycle. With this, an actual regeneration of the material sources is achieved at the end of the use time.
- No degradation or pollution of biological or technical material flows occurs in the loop phase.

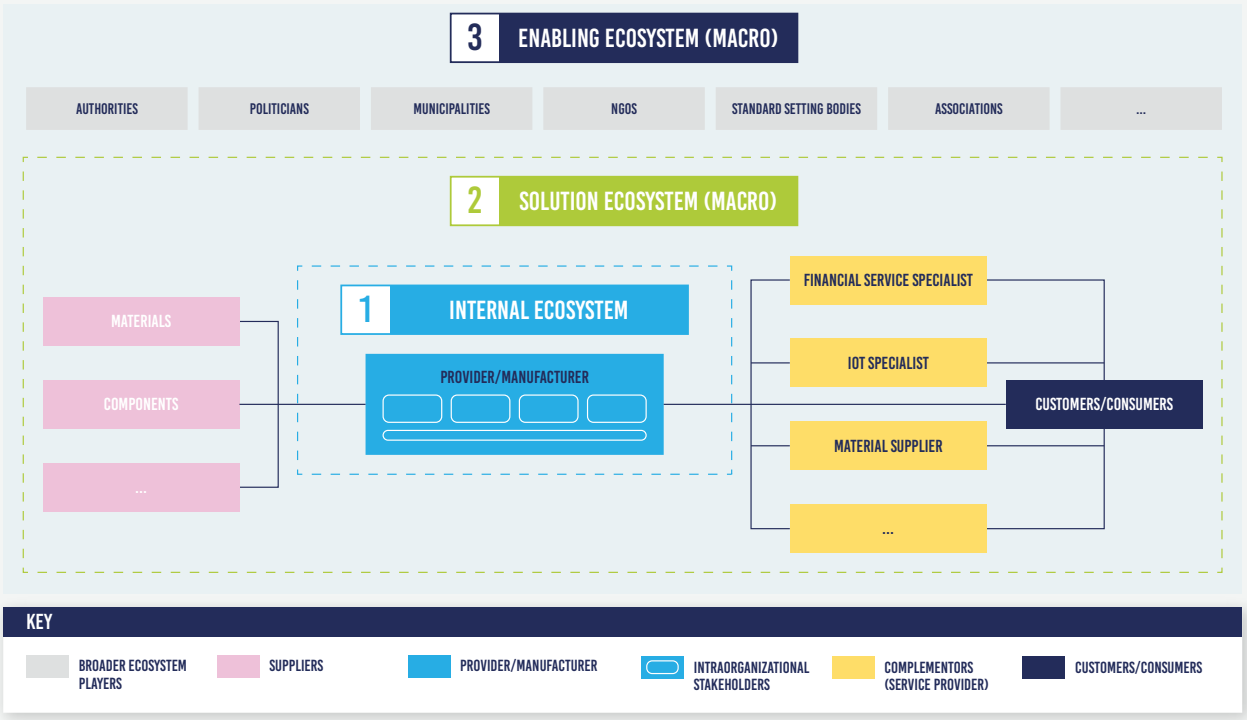
3.4 ESTABLISH THE INTERNAL AND EXTERNAL STRUCTURES TO MANAGE RESOURCE AND INFORMATION FLOWS

To implement XaaS models, it is important to take an ecosystem perspective both with respect to the internal organization as well as external collaboration partners. Few, if any, businesses have the financial resources and organizational capabilities to successfully design, develop and implement these service-oriented models by themselves at the necessary speed. For incumbent companies, switching to XaaS models can involve significant organizational change. For emerging companies, establishing XaaS systems from scratch involves a complexity of design choices. Seeking alliances with partners for jointly delivering the XaaS model can be critical (e.g. specialized service companies, digital/technology innovators, or suppliers). Typically, one of the actors in the partnership network is taking the role of a central orchestrator. What makes ecosystem design distinctive is that it requires a true system perspective. For instance, it is not sufficient to design the value creation and delivery model, it is also necessary to explicitly consider value distribution among ecosystem members.[63] The ecosystem perspective should differentiate between three levels (see Exhibit 14).

1) **Internal ecosystem**: intraorganizational activities and structures to manage the XaaS model.
2) **Solution ecosystem (micro)**: coordinating activities among partners to deliver the XaaS model.
3) **Enabling ecosystem (macro)**: collaborations and networks among partners within, across and beyond industry boundaries (e.g. to scale XaaS models).

EXHIBIT 14

The ecosystem perspective needs to differentiate between three levels.



Source: SYSTEMIQ collation based on Boston Consulting Group (2019).

3.4.1 INTERNAL ECOSYSTEM: STRENGTHEN THE ORGANIZATIONAL STRUCTURE AND PROCESSES

For many companies, establishing a consumer-centric (vs. product-centric) XaaS model requires a collective effort and changes within the internal organizational model. In particular within established incumbents, XaaS transitions have to ensure strategic embeddedness, adapt organizational structures and build new capabilities. Beyond that, it is essential to assess whether the IT/technology stack is ready to manage a circular business model and processes (e.g. ERP, predictive analytics).

3.4.1.1 STRENGTHEN STRATEGIC EMBEDDEDNESS, ORGANIZATIONAL STRUCTURES AND CAPABILITIES

The strategic embeddedness of XaaS models is of utmost importance and requires support by the senior decision-makers within the company. Putting XaaS models high on a company's strategic agenda is not only important to ensure a high ambition level that combines economic and environmental impact, it also ensures that internal XaaS initiatives receive the required buy-in and resources. Hence, there is a need for committed C-level managers (and potentially even key shareholders) to sponsor such a change.[64]

In some organizational areas, XaaS models entail a fundamental shift to key activities and processes. For example, a stronger service orientation and lifecycle product responsibility may require new structures and processes. Companies need to (a) decide on how/where to integrate XaaS models within the actual organizational structure to ensure flexibility and independence for XaaS initiatives but also to synergize with the core business and strengths. In addition, (b) controlling/KPI processes and (sales) incentive schemes may need to differ for XaaS models and adjust for the initial revenue gap and the recurring revenue logic. Moreover, traditional sales companies may need to adjust sales incentives and an accounting mindset that properly reflects the material value and is tailored to product-service-bundles that represent revenue-generating assets. Overall, (c) processes need to be streamlined towards agility to deal with more (internal and external) information and be responsive.

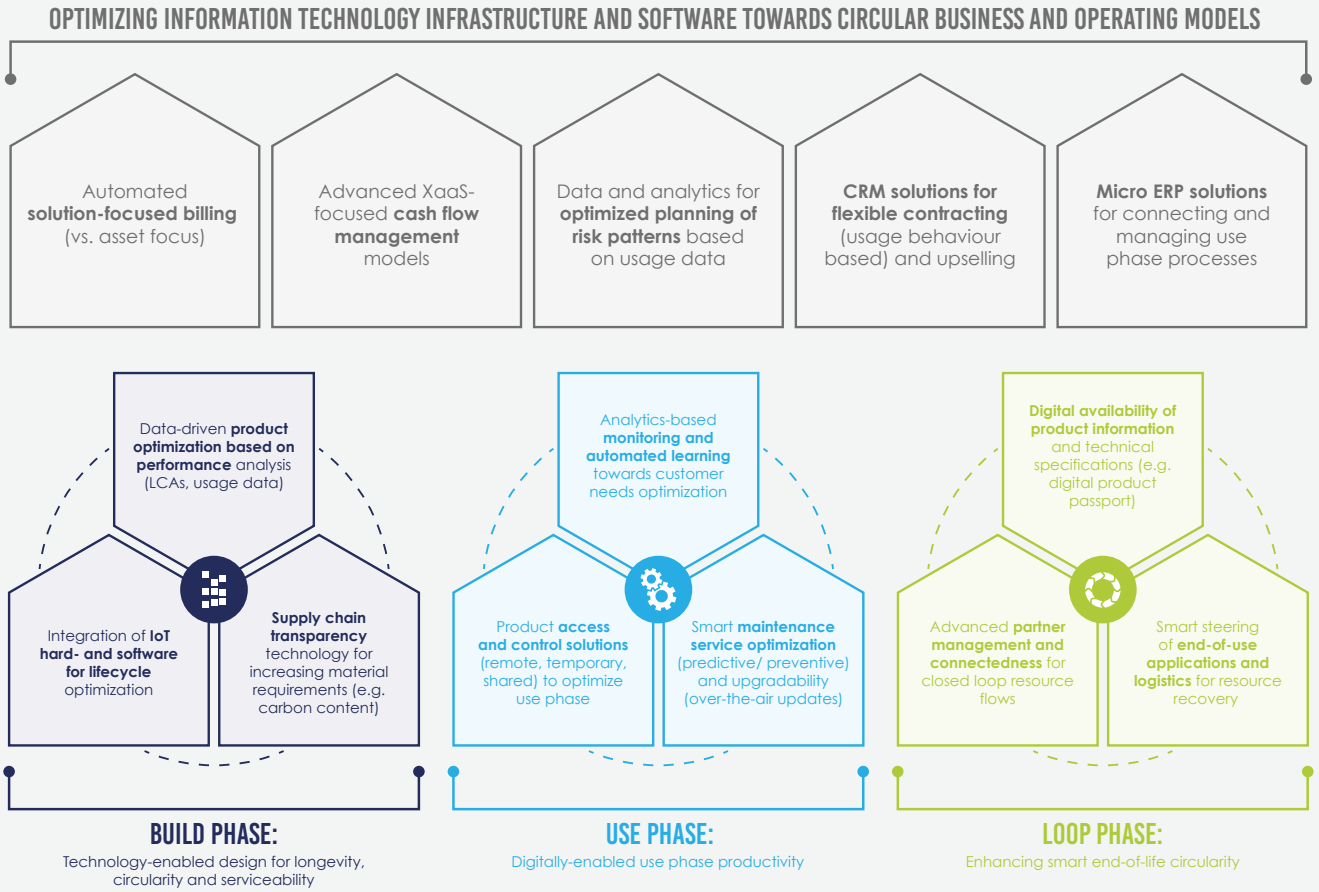
Since XaaS models typically require more interdisciplinarity among different organizational units (e.g. sales, product development, customer service, controlling, finance, treasury, and supplier management) and potentially new company activities, collaboration may require breaking organizational silos. Simple measures such as creating positions of responsibility that promote the exchange within the departmental teams are essential. This can be achieved by, for example, linking the development department, the design department and the repair/aftersales department. Optimizing the organizational structure may benefit from exploring new ways of working (e.g. agile sprints, scrum). A new set of capabilities may be required to realize XaaS offerings – including both soft skills and hard functional skills (e.g. carbon footprint/LCA expertise). Please refer to Appendix B.3 for further details on strategic embeddedness and organizational change.

3.4.1.2 ADDRESS IT/DIGITAL REQUIREMENTS FOR XAAS READINESS

Leveraging IT and analytics capabilities is important to achieve XaaS readiness. With value creation increasingly relying on IT/digital capabilities and ecological regulation raising data requirements, investments in digitalization and associated capacities are rising steadily.[11,65] The IT/digital infrastructure and application landscape of an

EXHIBIT 15

IT/digital capabilities will need to reflect change requirements of XaaS (non-exhaustive).



Source: SYSTEMIQ.

internal ecosystem has to be ready to enable XaaS models from several perspectives; in particular, by supporting involved business units to manage changed processes and data needs, by interconnecting the business functions internally, by actually offering the XaaS services along the full product lifecycle, and by ensuring necessary data flows through interoperability with the external partner ecosystems. A set of important IT/digital change requirements for key applications in the business and operating model is summarized in Exhibit 15. Appendix B.4 presents a further elaboration.

For many organizations this might require a substantial investment in their IT/digital capabilities or a more intense collaboration with (new) technology service providers. Developing IT/digital solutions that enable and accelerate corporations to shift to XaaS models represents a vital field for entrepreneurial innovation (see Case box 10).

CASE BOX 10:
NITROBOX – ENABLING BILLING AND PAYMENT FOR SERVICE-ORIENTED BUSINESS MODELS

Nitrobox is a smart software solution (SaaS) provider enabling companies to implement monetization models for complex digital business models (transaction-based, usage-based, as a subscription or hybrid models). The Nitrobox Agile Monetization Platform connects customer and order applications with existing backend systems such as SAP. It provides comprehensive order-to-cash/ partner-to-pay functions such as convergent billing and invoicing, payment automation, contract management, and revenue recognition. Hence, it allows companies to roll out their new monetization strategies within weeks without having to change legacy ERP systems and supports the transformation towards innovative business models such as multi-sided platforms and marketplaces, Equipment-as-a-Service and IoT models, on-demand and smart mobility services.[66,67]

3.4.2 SOLUTION ECOSYSTEM (MICRO): SET UP COMPLEMENTARY PARTNERSHIPS FOR XAAS DELIVERY

The micro-level solution ecosystem entails a collaboration of complementary partners that focuses on jointly delivering a XaaS model as well as possible. As indicated in Exhibit 14, the solution ecosystem typically includes suppliers and customers, but also complementary service providers or functional specialists which help to deliver the XaaS model. Beyond just defining relationships as in linear value chains, the development of XaaS models may shift the classic boundaries of the company (e.g. managing data or new service levels, or establishing material loops). In XaaS models, the success of all partners involved should be linked to the outcome/ performance of the product-service-bundle, to fully align incentives towards customer success. To meet customer needs, XaaS providers may have to go beyond existing relationships and search for partners that contribute new resources and capabilities. For example, technology platform start-ups such as Nitrobox, circuly and lizee now offer complementary digitalization capabilities to traditional companies that seek to experiment with XaaS models, e.g. support logistics, online retail and predictive maintenance.

Ecosystem partners should develop a shared vision in line with the sustainable customer value proposition. This is why ecosystem partners should be involved in the development of the XaaS model early on to co-create the vision, business case, and roadmap for the service-oriented business model.

Solution ecosystems should be very clear with respect to roles in the ecosystem. A well-designed governance structure secures ecosystem partners' mutual agreement about positions (where each

partner is situated) and activity flows (what each partner is responsible for doing).[68] Importantly, partners have to clarify roles such as the **orchestrator**: a core firm (e.g. the producer or platform host) that acts as XaaS model provider who builds the platform and assembles the partners. The orchestrator plays a critical role within the ecosystem and must ensure a fair and sustainable value distribution. The role of the lead firm or orchestrator of the ecosystem (which could, in theory, be any actor in the solution ecosystem) cannot be overstated as it can provide a clear vison and narrative as well as sufficient incentives for the ecosystem to thrive.[32] The orchestrator needs to balance three competing objectives: maximizing the size of the total pie; enabling all important domains (groups of participants) of the ecosystem to earn enough profit to ensure their ongoing participation; and capturing its own fair share of the value.[69] **Suppliers and complementors** contribute a specific product or service to the XaaS model and can participate in more than one ecosystem, particularly if they provide important components that represent a bottleneck for various ecosystems (e.g. reverse logistics competencies, material recovery). Complementors may also include financial institutions to help bridge the initial revenue gap associated with these models and assume part of the transferred risk.[35]

3.4.3 ENABLING ECOSYSTEM (MACRO): DEVELOP AN EXTENDED NETWORK FOR SCALING XAAS

The enabling ecosystem focuses on creating supporting structures and networks beyond the boundaries of the solution ecosystem. The design (e.g. shared vision, roles, interaction) of the enabling ecosystem depends on the goals that the orchestrator and respective partners want to achieve with it. Several objectives can be pursued through enabling ecosystems and drive respective partner constellations:

- The orchestrator (e.g. producer or platform host) wants to **scale the XaaS model** and is looking for cooperation with politics or industrial unions.
- The orchestrator wants to go beyond existing relationships to **strengthen value creation in a specific region** and is looking for cooperation with regional partners.
- Companies (within an industry or specific XaaS model archetypes) may set up alliances to **further develop specific innovations of common interest** that support everybody's circular business models.
- Companies want to use enabling ecosystem partnerships to **accelerate decarbonization** across a sector.
- Companies aim to **partner towards shaping a new industrial vision** (e.g. Industry 5.0 transition to a sustainable, people-centred and resilient European industry).

The macro-level enabling ecosystem may include a diversity of relevant stakeholders from politics (e.g. relevant communities, municipalities, nations), society (consumer associations and NGOs), business/industry (e.g. associations, standard-setting bodies) and research (e.g. universities, research institutions, innovation hubs). Exhibit 26 in Appendix B.5 summarizes a set of potential activities that enabling ecosystem players can contribute to foster the economic and environmental value creation potential of XaaS models. To design the respective ecosystem activities, initiating XaaS orchestrators may be guided by questions like: Which topics related to building and scaling XaaS impact require support from outside of the solution ecosystem? What should be the key objective of the enabling ecosystem? Who can help to scale environmental impact at the necessary speed? Who are the right parties to collaborate/ join forces with?