



EUROPEAN UNION
European Regional
Development Fund

PRODUCT-AS-A-SERVICE IN THE CIRCULAR ECONOMY

The nine critical challenges and how to fix them



FOREWORD

Against a backdrop of rapidly increasing throughput of energy and materials, the circular economy as a concept has attracted increasing interest in recent years. Resource use has more than tripled over the last fifty years and is bound to double again in the coming decades unless something is done to fundamentally change course. The International Resource Panel (IRP) estimates that the extraction and processing of materials, fuels and food make up more than half of global carbon emissions and 90% of the loss of biodiversity. To continue business as usual would endanger our planetary life-support systems, whether due to climate change, ecosystem decline or resource depletion.

“The exploitation of nature has been and still is more or less free of charge. It has led to a huge market failure.”

By moving from linear to circular production models the pressure on natural systems would lessen considerably. Nothing is 100% circular, however. All materials degrade and disperse over time and with use. Still, many studies confirm that there are huge gains to be made – economically, socially and environmentally – by moving from linear to circular material flows and by keeping products and materials in use for as long as possible.

But even if a circular economy appears obvious it will not happen by itself. And the sad truth is that there has been a lot of talk about circularity recently, but too little real action. The barriers to change are plentiful. During much of history natural resources were perceived as both abundant and cheap. The capacity of nature to absorb waste and residues was looked upon as infinitely large. Producers rarely paid the full costs of production; The exploitation of nature has been and still is more or less free of charge - It has led to a huge market failure.

Furthermore, most business models have favoured high material throughput and short product lives. In

addition, consumer patterns were developed without considerations given to sustainability.

The linear production model is dominant today because of massive market failure. The negative externalities caused by the extraction, production, and use of natural resources are not reflected in market prices. To overcome these barriers, several things need to happen. Business models, consumer preferences and lifestyles have to be changed. Policy frameworks must be reconsidered to correct for market failures. They must provide the necessary incentives to move the economy in the right direction.

To many people, the circular economy is seen primarily as increased recycling. Indeed, recycling has an important role to play. Material recycling saves a lot of energy and hence lessens pressure on fragile ecosystems. For instance, each recycled tonne of steel and iron scrap replaces the mining of 1.5 tonnes of iron ore. Emissions are significantly reduced: with each tonne of steel scrap, one tonne of CO₂ is saved. The efficiency of recycling of some other metals is almost just as high.

However, it is important to emphasise that recycling is no silver bullet. Keeping products and materials in use for as long as possible is more important. In slowing material flows, for example through reuse, repair and reconditioning, product life spans are extended, and the production of new goods is avoided or postponed.

Products-as-a-Service (PaaS) is a promising model that can help extend the lifespan and utilisation for many different products. The provider retains ownership or control for the product during its use-phase. In doing so the relationship between producer and user/consumer is turned upside down. Strong incentives are created to keep the product – and its constituent materials – in use for longer. The provider moves from offering a product for sale to selling performance. The concept is far from new. Hotels and inns, taxis, railways and airlines, even bridges and tunnels, do this. Among consumer products we find examples such as photocopying. Rentals are similar – everything from

apartments to vehicles, tools, equipment, and books in libraries can be rented. The general idea is to make use frequent, and to make products last as long as possible.

However, several challenges have meant that the success of PaaS has so far been limited. For example, products are sold with fairly short-term guarantees against manufacturing defects. Those selling performance are considered continually liable for that function and performance. Another challenge is finance. When a product is sold, the revenues come up-front. When selling performance, revenues are spread over time. This means liquidity is often seen as an obstacle. At the consumer end there are additional barriers to do with culture, image and status. Many people simply prefer ownership. One reason for this may be flawed perceptions of the costs of ownership versus paying for performance.

The report “Product-as-a-Service in the Circular Economy” is very timely. Society’s interest in resource efficiency and circularity is growing – both from governments, businesses, and citizens. Awareness is increasing about the urgent need to do away with production and consumption systems that are unsustainable. Inefficiency and waste must be tackled. More intelligent ways to provide for human needs must be thoroughly explored.

While activities like reuse, refurbishment, remanufacturing, and recycling are pretty mainstream, the concept of PaaS is still not well-understood. PaaS is a great enabler for these circular operations and the report helps explain the concept as such. Moreover, it identifies nine challenges for businesses and consumers to overcome to make PaaS operational at scale so it can make a significant contribution toward establishing the circular economy. The report offers important and detailed advice on how to address the various challenges – both regarding changing business models and consumer preferences. Special focus is devoted to Small and Medium-sized Enterprises (SMEs) and to Business to Consumer (B2C) offerings.

The final chapter reiterates the important point that policy frameworks must be changed to address market

failures. It is simply too cheap to exploit nature instead of choosing secondary material. A tax shift – lowering taxes on labour and increasing taxes on the use of virgin materials – would make a huge difference. It would create an incentive to design longer-lasting products and business models that sell performance rather than objects.

Another important suggestion is for the public sector to take a lead in the move towards PaaS business models. Public sector agencies can stimulate the development of PaaS by including circular economy metrics and functional requirements in their procurement. A third intervention by the public sector – briefly mentioned in the report – would of course be to legislate a Full Producer Responsibility for materials and objects. By doing so all costs of risks and waste (including final disposal) would have to be internalised. In such a system PaaS business models would appear very natural for companies.

All in all, this report addresses a crucial knowledge gap in society. The circular economy faces two large and interconnected barriers. First, too little action – which can of course be attributed to flawed incentive structures. Second, too little understanding of what circular economy business models would look like. It is therefore critical to explain in detail what PaaS business models would look like and what benefits they bring, both for businesses and consumers. The report offers ample advice. It should be widely read by all actors in the marketplace, included – of course – policymakers.



Anders Wijkman

Chair, Circular Sweden

PREFACE

The circular economy as a concept has made an impressive journey in the last decade. In just 10 years, it has gone from niche to mainstream, and today countless businesses as well as countries have presented their own circular economy strategy or action plan.

For those interested in the circular economy at more than a shallow level, it is obvious that it requires a massive, systemic transformation in how we make, use, and recirculate products and materials. It is equally clear that it would generate large benefits to society. Service-based business models (and the many nicknames associated with them) have been regarded as a keystone of this transformation from the get-go. As we'll discuss, they are necessary to create circular product and material flows, and have the potential to create more economic value than their ownership-based counterparts.

“We felt we needed not only to help businesses articulate their challenges, but also to help them deal with them in a systematic way.”

However, it is also plain to see that after 10 years of trial and error, innovation, and action plans, the growth in market share of 'Product-as-a-Service' (PaaS) has been slow at best. It is more than 60 years since the frontrunner of PaaS, Rolls-Royce's Power-by-the-hour model, was introduced, yet only a handful of truly transformative models have emerged.

Why? Could it be that the PaaS model comes with specific challenges not faced by companies who simply sell things? Could it be that those challenges are difficult because they are new and unfamiliar? And are capabilities to address them extra hard to come by given how new and unfamiliar PaaS itself is in most industries? These are some of the questions we felt needed to be answered when we started this project.

We felt we needed not only to help businesses articulate their challenges, but also to help them deal with

them in a systematic way. The report you are just about to read is therefore not the end of a journey, it's the beginning. The beginning of developing a practical methodology for companies to successfully build and launch PaaS models in their own business context. You will find a first iteration of this methodology below. It's intended as a launch pad to a phase of testing, evaluation, and refinement together with the Small and Medium-sized Enterprises (SMEs) active in the PaaS space.

We believe that businesses are in the driver's seat of the transition towards a circular economy. But they need help to overcome the critical challenges holding PaaS back. And they need help to even out the odds stacked against those who dare to lead a risky, transformative new enterprise. We are hopeful this project will help finally making PaaS business models as successful as they promised to be in the beginning. We hope it will accelerate the transition to a circular and sustainable business sector.

Enjoy the read!



Elin Bergman

COO & Vice Chair,
Cradlenet



Mats Linder

Head of Consulting,
Stena Circular Consulting

IN SUPPORT OF THIS REPORT

Products-as-a-Service is a big idea whose time has surely come, as businesses and governments now look for ways to save consumers money and deliver more value for society with fewer resources and less waste. Our challenge now is to scale up the great PaaS cases that already exist and to bring this business concept to the heart of our economy. Essential reading for industry leaders, policy makers and citizens!

Ben Dixon

Partner and Head of Materials and Circular Economy — Systemiq

I found the challenges for PaaS described in this report very familiar. As one of the early pioneers in smart reuse systems for cities, we have had to navigate these first-hand whilst innovating and scaling internationally. Great to see helpful solutions laid out here for others to take onboard.

Safia Qureshi

Founder & CEO — ClubZero (clubzero.co)

As a do-tank we believe it is essential for a sustainable development to move from talking to innovative, circular and collaborative doing. This knowledge packed report is a good support for this shift. It raises awareness on how to overcome barriers identified with PaaS but foremost it works as a handbook on circular business strategies, guiding companies in practice. In short, a much needed report that inspires action.

Maria Smith

General Secretary — Axfoundation

Moving from linear to circular is a multi-trillion-dollar business opportunity. More and more organisations around the world have begun to see the benefits and are exploring models such as product-as-a-service to accelerate the transition. This report provides helpful analysis and guidelines about key challenges for such service-based business models, and how innovating companies might overcome them.

Rob Opsomer

Executive Lead, Systemic Initiatives — Ellen MacArthur Foundation

For financial markets to support transition to circular business models, understanding the PaaS risks and opportunities is key. PaaS comes with high capital requirements and needs to be structured in a way that enables external financing at attractive terms. This report is a great introduction for lenders and investors to this very important subject.

Petter Lindblad

Investment Director — P Capital Partners

The challenges we are facing at the planetary level are so grave that we need to innovate in the way we, as humanity, operate.

The good thing is that the novel circular economy and PaaS models are so much more beneficial and compelling that I believe from my heart that we will succeed.

Petr Báča

Founder & CEO — MiWa (miwa.eu)

A shift towards circular business models is crucial to be able to live and do business within planetary boundaries. But the shift is too slow still and this report highlights the obstacles but also what actions need to be taken.

All businesses that want to secure long-term success and prepare for future market conditions should read this report. It can inspire businesses to start investigating PaaS models and be a guide on how to adapt your business for a true circular economy.

Elin Larsson

Program Director — RE:Source-SIP

ACKNOWLEDGEMENTS

Project Team

Mats Linder, Head of Consulting, Stena Circular Consulting

Märta Bergfors, Project Manager, Stena Circular Consulting

Felicia Gustafsson, Analyst, Stena Circular Consulting

Emmanouil (Manos) Milathianakis, Analyst, Stena Circular Consulting

Shanmuga Kumar, Analyst, Stena Circular Consulting

Elin Bergman, COO & Vice Chair, Cradlenet

Michel Bajuk, Director, Cradlenet

Jan Agri, Founder & Senior Advisor, Tricircular AB

Contributions

Liv Andersson, Project Manager, Stena Circular Consulting

Astrid Rud Pedersen, Analyst, Stena Circular Consulting

Fredrik Byström, Analyst, Stena Circular Consulting

Stina Klingvall, Senior Consultant, Stena Circular Consulting

Olof Hällerman, Senior Consultant, Stena Circular Consulting

Advisory Board

Hervé Corvellec, Professor at the Department of Service Studies, Lund University

Hanna Skoog, Program Director Circular Economy, Axfoundation

Karin Tell, Customer and Business Development, Almi AB

External Contributors

Amanda Cawood, Project manager, Accus

Anneli Selvefors, Researcher, RISE Sustainable Business

David Knutsson, Founder, Parently

Erik Valvring, Innovation Strategist, Science Park Borås/CircularHub

Fredrik Karlberg, Founder, Jonna AB

Gustav Hedström, Business Controller & Innovation, Houdini Sportswear AB

Jakob Hansson, Structured Asset Finance, SEB

Joakim Hilding, Founder, Furnlease

Joel Smedberg, CEO, Brighteco

Johanna Norrman, Former CEO & Co-founder, Its:Released

Linda Nilsson, Marketing Manager, Elis Textilservice

Magnus Engström, Founder, Envivo

Martin Willers, Co-founder & CEO, Transparent Sound

Mats Olausson, Senior Advisor, Climate and Sustainability Finance, SEB

Michiel De Smet, Sustainable Investment Expert, National Bank of Belgium

Ove Lidström, Head of Business Development & Innovation, Foxway Group AB

Pontus Björkdahl, Head of Sustainability, Svenska Retursystem

Sebastian Holmström, Sustainability Manager, Inrego

Thomas Eliasson, Finance Director, Elis Textilservice

Viktor Tingström, Co-founder, Lisa&

Yann Toutant, Founder and CEO, Black Winch - the As-A-Service Experts

Cradlenet



EUROPEAN UNION
European Regional Development Fund

STENA
RECYCLING

We would like to extend our thanks to everyone who participated by responding to the survey linked to this report. The input provided was crucial to developing the structure and content of this report.

The authors thank the European Regional Development Fund (ERDF): REACT EU alongside the Swedish Agency for Economic and Regional Growth (Tillväxtverket) for funding the project. We express our gratitude to all external contributors, interviewees and their respective organisations who have contributed their time and knowledge to this report.

DISCLAIMER:

This report has been prepared and produced by Stena Circular Consulting, a part of Stena Recycling Group, and Cradlenet. The authors would like to thank the organisations and individuals that contributed to this report for their constructive and valuable input. Contributions to this report by an external stakeholder do not necessarily indicate any kind of partnership or agency with the authoring organisations. All views and recommendations expressed in this report are the responsibility of Stena Circular Consulting and Cradlenet and do not necessarily reflect the views of contributing and/or endorsing parties.

EXECUTIVE SUMMARY

PRODUCT-AS-A-SERVICE — A FAST TRACK TO THE CIRCULAR ECONOMY

There is a growing interest from businesses to adopt circular economy practices. This demands a new approach in which the linear take-make-discard model is replaced by one where products and materials are kept longer in the economy to add more value. But in practice, implementation at scale is held back as it is difficult to make a business case for activities that generate value beyond the point of sale. This is especially true in the case of small and medium-sized enterprises.

In Product-as-a-Service (PaaS) business models, the provider retains ownership or control of the product throughout the use-phase. As such, these businesses have a much stronger incentive to maximise product utilisation (since that is what they get paid for). It's also in their interests to reduce the total number of products required and their lifecycle cost (LCC). Since a significant part of the LCC is driven by resources (raw materials, energy, waste etc.), the PaaS model inherently contains a business logic aligned with circular economy objectives. For this reason, PaaS has been highlighted as one of the cornerstones in a low-carbon, resource-efficient economy, from the seminal work by Walter Stahel [1] to the ground-breaking reports by the Ellen MacArthur Foundation [2].

As has been thoroughly documented in multiple studies, PaaS models create additional value for both the provider and the customer.

- Providers get closer customer relationships, recurring revenue streams and enhanced competitiveness.
- Customers obtain value in several forms, for example: direct cost reduction through minimised total cost of ownership, more functional value through flexibility and adaptiveness to technology development, and the ability to use a product when they need it.

In general, a PaaS offering has the potential to succeed when it leads to an overall reduction in total cost of ownership (TCO) and product LCC, and where those cost savings are split between the provider and customer in a reasonable way. This mechanism has already been put to use for decades in several industrial or B2B settings. So far however, adoption of PaaS business models has fallen way short of their identified potential. This report reviews the main challenges behind the sluggish penetration in the market and identifies potential actions by its stakeholders to address them.

NINE CHALLENGES HOLDING PRODUCT-AS-A-SERVICE BACK — AND WHAT TO DO ABOUT THEM

Through extensive stakeholder interviews supported by literature review, this report has identified nine crucial challenges to PaaS business models. They fall into one of three broader categories: Customer acceptance, operational and capability-related costs, and financial risk. Table 1 gives an overview of the challenges and the associated actions. What's important to note is that each challenge is addressable by the PaaS provider. They can choose to:

- refine their value proposition to customers
- invest in capabilities and relationships
- tune their business model

Market and regulatory conditions could of course be more enabling to PaaS business models than they are today (see below), but the nine challenges show that at its core, the sluggish development of PaaS is a business-centred problem that can be solved by businesses.

TABLE 1: CHALLENGES AND ACTIONS

The table shows an overview of the challenges and actions identified in this report. Please note that the actions may contribute to solving more than one challenge.

CATEGORY	CHALLENGE	ACTION
Customer acceptance	1. Customers like ownership 2. Customers underestimate total cost of ownership 3. Transaction costs causes inconvenience	Really understand customer needs Iteratively develop services with added value Explode the myth that ownership is cheap Explore other market segments
Operational and capability-related costs	4. Increasing production costs 5. Lack of PaaS specific capabilities 6. Immature ecosystem for partnerships	Optimise operational processes Build a devoted PaaS team Adjust goals and metrics
Financial risk	7. Asset-heavy business model 8. Poor liquidity 9. Difficulty accessing capital	Adopt efficient Asset Management Shift to PaaS gradually Build a solid business case

A METHODOLOGY FOR SPEEDING UP THE ADOPTION OF PAAS BUSINESS MODELS

Having identified nine principal challenges to PaaS and how to address them, this report presents a four-part methodology to better equip businesses for a PaaS transition. The methodology is created to be used by practitioners, in particular SMEs, and builds upon several existing business tools modified to fit a PaaS context. It includes tools that help practitioners assess the potential and feasibility of a PaaS business model in their own business context, and to avoid or manage the most critical challenges identified in the report.

The methodology consists of four parts:

- Identify your PaaS advantage. As a first step, assess the suitability of your product and customer segment for a PaaS business and ideate on how you can address potential challenges.
- Design for added customer value. Next, deepen your understanding of customer gains, pain points, and requirements. Use these insights to build an attractive value proposition tailored to customer needs, and map out which activities are required to operate the business model.
- Build the PaaS business case. Third, identify the window of viability for the business model, choose a revenue model, and prepare a solid business case to investors or financial institutions.

- Identify your core assets. The final step is to decide which capabilities and assets to build in-house, which it makes sense to access through collaborative partnerships, and which can be outsourced. The goal is to optimise operations, asset structure and competitiveness.

CREATING THE CONDITIONS FOR PRODUCT-AS-A-SERVICE TO THRIVE

While there are challenges to PaaS that businesses can work to mitigate or overcome by themselves, the sluggish uptake of PaaS demonstrates how both market and regulatory failures have created an unhelpful institutional and financial environment. To accelerate the circular economy transition, policy makers, the public sector, and financial institutions, are urged to take action to create a more enabling environment for PaaS. Proposed actions include:

- Shape policy instruments to incentivise function over resource use. Policymakers need to consider the potential of implementing different policy instruments to favour resource-efficient business and consumption practices. A one-off tax on virgin finite resources (such as fossil carbon) is the obvious example. Despite being politically unsavoury, it is hard to argue against it. It would target a ubiquitous problem in the linear economy (it is cheap to be wasteful) while levelling the playing field

between PaaS (and multiple other sustainable practices) and more mature traditional business models. It does so without being solution-prescriptive.

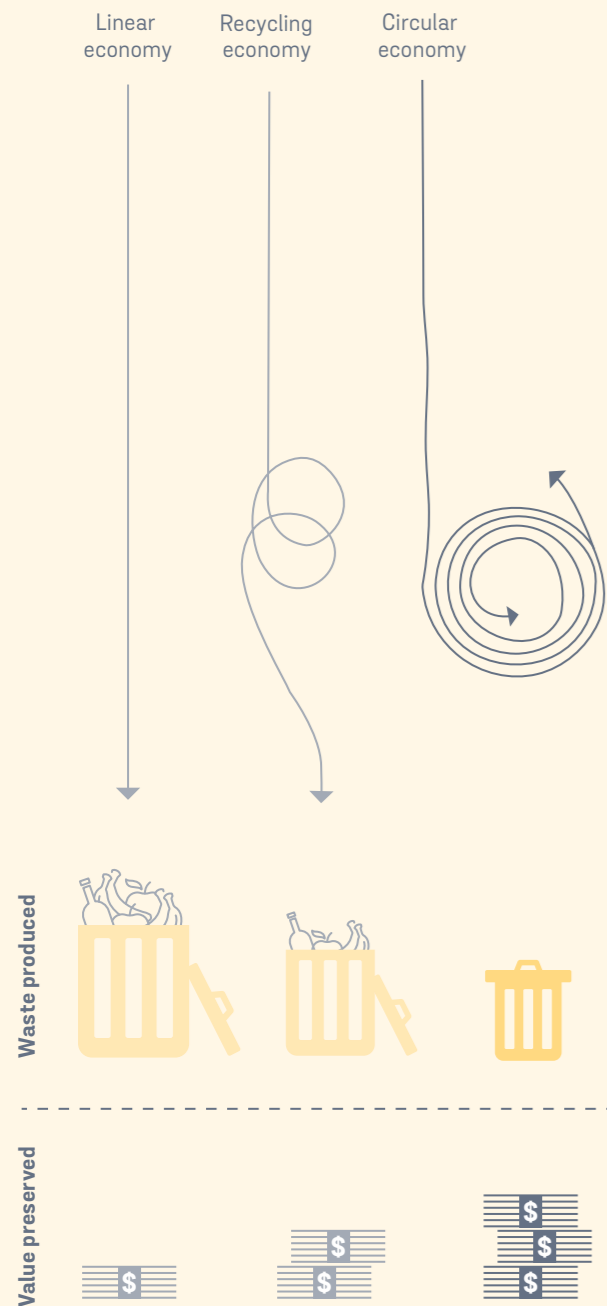
- Favour PaaS in public procurement. Public sector organisations and agencies can directly stimulate the development of PaaS business models by using circular economy metrics and functional requirements in procurement. Done well, it would be a significant market-making mechanism as well as saving public (ie, taxpayer) money.
- Redefine how value and risk is assessed by financial institutions. Financial institutions and investors need to innovate how they evaluate the financial viability of alternative business models. They further need to build expertise around PaaS to ensure they have the skills to support PaaS providers' sometimes unconventional needs. These include the ability to manage large balance sheets and distributed revenue streams.

Despite the lack of an ideal policy, regulatory and financial environment for PaaS, the conditions for a larger-scale breakthrough on mainstream markets have never been better. Crucially, two of the most important enablers already exist. First, the necessary digital infrastructure to manage complex networks of servitised products is no longer a far-off vision. There are now solutions for monitoring, transacting, swapping seamlessly, predicting timely maintenance and more. Second, awareness of the need to shift to a more circular economy has never been greater. It is even growing among the arguably most conservative group of customers: consumers [3].

We are more able than ever to put products in the service of the circular economy. The time for PaaS is now.

CIRCULAR ECONOMY

Increasing product utilisation, endurance and recirculation are key strategies to unlock the potential of a circular economy



PRODUCT-AS-A-SERVICE

Product-as-a-Service plays a crucial role in realising these strategies



Businesses and customers both benefit from the transition

CHALLENGES

To scale Product-as-a-Service to its full potential, nine key challenges across three categories need to be addressed



ENABLERS

The critical enablers for doing so are already here



LIST OF ABBREVIATIONS

B2B	Business to Business
B2C	Business to Consumer
B2G	Business to Government
BAU	Business As Usual
CAC	Customer Acquisition Cost
COGS	Cost of Goods Sold
CRR	Customer Retention Rate
EBIT	Earnings Before Interest and Taxes
EoL	End-of-life
EPR	Extended Producer Responsibility
KPI	Key Performance Indicator
LCC	Life Cycle Cost
LTV	Loan to Value
MRR	Monthly Recurring Revenue
OEM	Original Equipment Manufacturers
OPEX	Operating Expenditure
PaaS	Product-as-a-Service
PMV	Preserved Material Value
RFID	Radio Frequency ID
SMEs	Small and Medium-sized Enterprises
TCO	Total Cost of Ownership

TABLE OF CONTENTS

Foreword	2
Preface	4
In support of this report	5
Acknowledgements	7
Executive summary	9
List of abbreviations	13
Introduction	15
Part 1: Understanding Product-as-a-Service	
1. Product-as-a-Service — a fast track to the circular economy	18
1.1 The power of product ownership	18
1.2 Creating and getting paid for additional customer value	21
1.3 Product-as-a-Service in practice	23
1.4 Rewarding systemic cost reductions	24
2. The nine challenges and how to fix them	29
2.1 Customer acceptance	30
2.2 Operational and capability-related costs	34
2.3 Financial risk	38
Part 2: Taking action	
3. A methodology for speeding up the adoption of Product-as-a-Service business models	45
3.1 Identify your Product-as-a-Service advantage	46
3.2 Design for added customer value	50
3.3 Build your Product-as-a-Service business case	55
3.4 Identify your core assets	58
4. Creating the conditions for Product-as-a-Service to thrive	61
4.1 Three enablers to level the playing field, boost demand and lower financial risk	61
4.2 The most important enablers are already here	63
References	64
Reference list of the interviewees	70
Additional resources	71
Contact	72

INTRODUCTION

ABOUT THIS REPORT

The aim of this report is to develop insights on how businesses can improve the success rate of Product-as-a-Service business models. The insights are presented in two separate parts. The first part, Understanding Product-as-a-Service, establishes a basic understanding of PaaS business models and their benefits. Specifically, it outlines the most critical challenges that hinder their uptake in the market today and suggests actions to overcome them. The second part, Taking Action, presents a methodology developed for Small and Medium-sized Enterprises (SMEs) to design and operate such models more effectively. The insights presented in this report build upon the analysis of data acquired from literature reviews, interviews with Swedish SMEs previously or currently operating a PaaS business model, interviews with relevant experts from the financial and academic sectors, and an online survey.

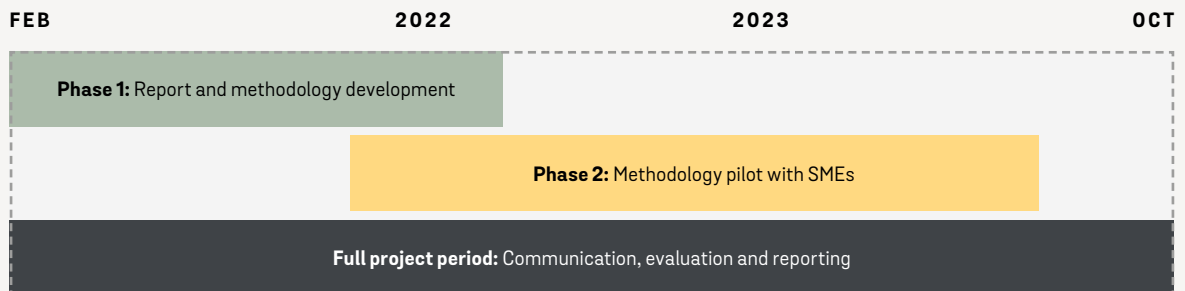
The challenges faced by companies are not fixed but are connected to current societal, economic, and environmental trends, challenges, and available solutions. Therefore, the purpose of this report is not to present a complete and exhaustive list of literature findings. Instead, the ambition has been to highlight the actual and most critical challenges faced by companies today and how to address them based on available market solutions, without expecting that

those actions in and of themselves are sufficient as systemic changes. The underlying approach may be summarised as “what can we do here and now”. Chapter 4 contains a set of suggestions for financial and societal institutions to create more enabling conditions for systemic change, of which PaaS models are one building block.

The scope of this report does not extend to investigating the environmental potential of PaaS as this has been done in previous studies (see eg [4], [5], [6], [7]). It focuses on understanding the challenges in making a PaaS model work and scaling it up. It’s our starting point that PaaS, when designed to ensure enhanced resource efficiency, is a critical vehicle to accelerate the circular economy transition and has the potential to generate environmental benefits [8].

This publication has been produced as part of a collaborative project between Stena Circular Consulting, a part of Stena Recycling AB, and Cradlenet, a cross-industry network for businesses and organisations that seek to transition to a circular economy. The project is funded by the European Regional Development Fund (ERDF) and runs from February 2022 to October 2023. This publication serves as the basis for a methodology that will be tested and further improved together with Swedish SMEs during a pilot phase that runs between September 2022 and May 2023.

PROJECT TIMELINE



WHY THIS REPORT?

The global economy is almost entirely based on the linear “take-make-waste” model which has dominated since the early days of industrialisation. The circular economy challenges that model. Our economic model is heavily reliant on raw material extraction and emissions-intensive processing [9]. These lead to negative environmental impacts such as climate change, biodiversity loss, irreversible resource depletion, and pollution. During the last decade, the circular economy concept has gained attention as a measure to tackle these adverse impacts. It seeks to decouple economic activity from the consumption of finite resources while benefiting businesses, people, and the environment [10].

Despite the potential for the circular economy to deliver on both environmental and economic goals, implementation is slow. For example, the Circularity Gap Reports show that only a fraction of materials used globally reaches a second life. And there are limited prospects of improvement in the Business-as-Usual (BaU) scenario [9]. In the EU, the circular material use rate has remained relatively stagnant in recent years. It increased from just 9.1% in 2006 to 12.8% in 2020 [11]. The lagging progress of the circular economy points to the urgent need to change how we conduct business.

Product-as-a-Service business models are highlighted as a key building block of a circular economy [12]. When users access products by subscribing or paying as they go, and when providers retain ownership and stewardship, products are kept in use and the negative environmental impact of consumption is reduced. In contrast to traditional business models designed to maximise sales (and production) volume, the PaaS business model creates incentives that motivate the adoption of circular economy strategies.

When a business continues to own the product through multiple use cycles, it makes sense to improve quality and durability, and ensure that it can easily be reused or achieve a high recycling value [13].

Despite their estimated benefits and several successful examples, PaaS business models have not yet gained a central role in the global economy. A key vehicle to accelerate PaaS is to enable implementation with SMEs. There are a plethora of examples of poorly designed and unsuccessful PaaS business models. The reason for this is multifaceted. Some suffer from the absence of the right conditions in the current

economic and regulatory system, whereas others have lacked the right internal resources [14]. Moreover, there is an absence of adequate methods and tools supporting PaaS implementation, especially in the case of SMEs [13] [15]. But as SMEs represent at least 80% of all global enterprises [16] and over 99% of European enterprises [17], in addition to being responsible for approximately 64% of the industrial pollution in the European Union [18], they must not be ignored. In fact, they constitute a critical channel to diffusing PaaS models into the global economy. There is thus an apparent need to support particularly SMEs in adopting the systematic methods and the tools necessary to transition to PaaS business models.

It is the hope of this report’s authors that the actions and methodology presented herein will be supportive in growing the implementation of PaaS.

WHO SHOULD READ THIS REPORT?

This report targets professionals or ecosystem actors that are interested in Product-as-a-Service as a business strategy to improve competitive advantage and facilitate the implementation of circular economy strategies. It is of relevance for professionals starting their business journey in servitisation – either through a start-up or through an existing business – or those aiming to improve their current PaaS business. It is also relevant for investors and financial institutions looking to seek deeper insights into PaaS, incubators and accelerators which support PaaS businesses, as well as policy makers and regulators eager to promote sustainable and circular economy business practices. In addition to the above, this report can also be read by individuals interested in circular business models and their adoption.

PART 1

Understanding
Product-as-a-Service

1. PRODUCT-AS-A-SERVICE — A FAST TRACK TO THE CIRCULAR ECONOMY

Product-as-a-Service is a cornerstone in the circular economy transition. Here businesses take a stand against take-make-waste, not for ethical or emotional reasons, but because the PaaS business model demands and rewards it. By adopting PaaS and retaining product ownership, businesses are better positioned to reap the financial benefits of circular economy practices. This is because increasing utilisation, designing for longer product life, and increasing operational efficiency are so vital to maximising revenue streams and lowering costs. In a PaaS business model, businesses become providers of function. New metrics, such as utilisation rate per product, will therefore record the success or failure of these new ventures. In addition, PaaS provides an opportunity for businesses to drive cost reductions occurring during all stages of the product lifecycle.

As illustrated by established examples in industry, PaaS aligns the provider's business objective with the actual needs of its customers. This better positions providers to deliver added value to their customers, and to improve their competitive advantage on the market.

1.1 THE POWER OF PRODUCT OWNERSHIP

There is a growing interest from businesses to adopt circular economy practices. But in practice, implementation at scale is held back by the challenge of creating a business case for investments that generate revenue or cost savings beyond the point of sale. This inhibits the transition from the existing linear model, where products are often designed for short-term use before they become waste [4], with low material recovery and recirculation. Even in cases where best-practice recycling systems are in place, material value is still lost due to factors such as products not being designed for efficient recycling (eg, due to material heterogeneity, presence of hazardous substances etc.) and lack of proper collection systems, to mention a few [19]. For example, in 2019, 24 out of 27 EU member states failed to hit targets for the collection of Waste Electrical and Electronic Equipment (WEEE) resulting in up to 4.8

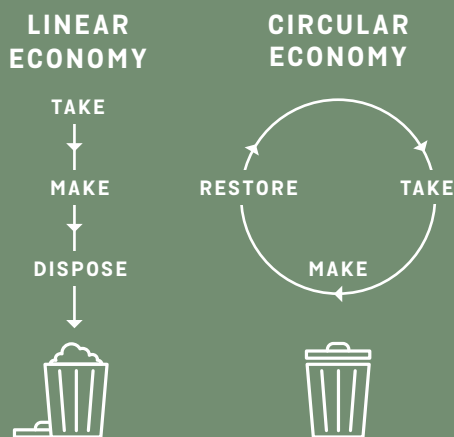
million tonnes of materials lost to reuse and recycling [20]. Furthermore, from the 4.5 million tonnes collected, just 3.6 million tonnes were recycled and prepared for reuse, leading to almost an additional one million tonnes of material value being lost [21]. Similarly, from the 353 million tonnes of plastic waste generated globally in 2019, 15% was collected for recycling (out of which 40% was disposed of as residues), 19% was incinerated, 50% was landfilled, and 22% ended up in open pits and terrestrial or aquatic environments [22].

To address this, businesses need to keep some control over products so as to enable circular economy practices such as repair, refurbishment, remanufacturing and recycling. Product control can be achieved through various strategies, such as deposit schemes and buy-back or take-back systems. One of the most critical strategies is the adoption of a PaaS business model [13].

CIRCULAR ECONOMY FAST FACTS

The circular economy is...

- an alternative to “take, make, waste” which relies on large amounts of materials and energy [89].
- a model of production and consumption which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing products and materials for as long as possible, thus extending the lifecycle of products [89].
- based on three principles: 1. Eliminate waste and pollution. 2. Keep products and materials in use. 3. Regenerate natural systems [10].



Note that this is a high-level and simplified overview of the circular economy concept. If you would like to get a deeper understanding of the topic, we recommend you to review the references used in this section and additional resources provided by the [Ellen MacArthur Foundation](#).

TWO MAJOR DRIVERS

Sustainability

Circular economy practices have the potential to tackle a range of environmental impacts by improving material efficiency and reducing resource extraction:

- ≈90% of land- and water-related environmental impacts, eg, biodiversity loss and water stress, are associated with resource extraction and processing [90].
- ≈70% of greenhouse gas emissions are associated with material handling and use. In only 50 years material use has nearly quadrupled, reaching above 100 billion tonnes in 2019 [9].

By doubling global circularity, estimates show that we can reduce global emissions by 39% and total material footprint by 28% by 2032 [98]. In hard-to-abate industrial sectors, the greenhouse gas reduction potential is even higher. Applying circular strategies to four critical materials – cement, steel, plastics, and aluminium – can reduce material production emissions by 40% or 3.7 million tonnes in 2050 [90].

Digitalisation

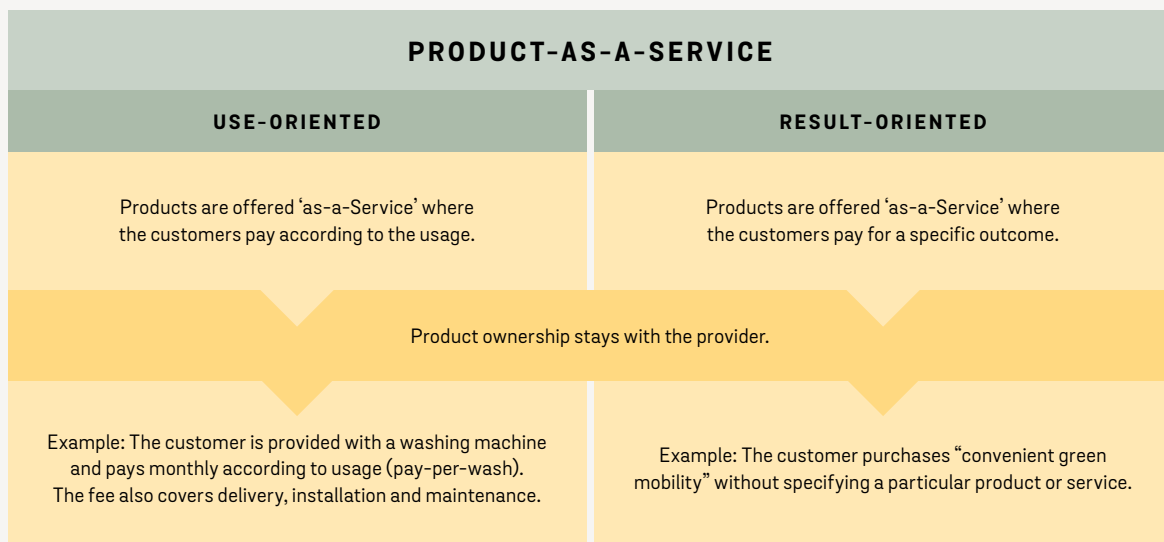
A circular economy can be further leveraged using innovative digital technologies such as AI, blockchain, and Internet of Things (IoT) [102]. These technologies support the development of smart services, as well as the implementation of circular economy practices. For example, by improving material and product traceability, enabling predictive maintenance, and optimising operations [101].

- A main driver of digitalisation is the number of internet users, which is expected to continue rising in developed markets and rise sharply in emerging markets, reaching approximately 80% of the emerging market population in 2032 compared to today's 50% [97].
- 63% of manufacturing companies are planning to implement and reshape digital strategies [95], and 50% of logistic companies plan on investing in AI and IoT in the next five years [96].

Product-as-a-Service originates from the term Product-Service Systems (PSS). PSS has been used in academia for more than two decades to describe business models that jointly combine products and services to fulfil a user's need [23]. These business models are commonly divided in three main categories: product-oriented, use-oriented and service-oriented [24]. In a product-oriented business model, the business still sells the product to its customer but integrates additional services in their offering as well.

In this report, the term Product-as-a-Service, or PaaS, is used generally to describe the two latter business models, ie, use-oriented and result-oriented (Exhibit 1). In both these business models, the provider keeps product ownership, and thus control, while offering usage or a predetermined result to the customer [4]. As previously mentioned, keeping product control is critical to creating a business case for the implementation of circular economy practices, and therefore, only these two categories are included in the scope of this report.

EXHIBIT 1: TYPES OF PRODUCT-AS-A-SERVICE BUSINESS MODELS INCLUDED IN THE PROJECT SCOPE



HOW PRODUCT-AS-A-SERVICE DIFFERS FROM TRADITIONAL RENTING AND LEASING

The difference between PaaS and leasing is that the products included in the offering are not intended to be sold after a limited period of use when they still have a high value. The PaaS provider instead maintains the same products in use for as long as possible.

In a PaaS business model, the customers usually pay either according to the time they use the product, for a predetermined period of use, or for a specific function. Business models where the customer rents a product and then purchases it at the end of the contract are not included in the project scope.

There are, however, countless ways to combine a PaaS business model with elements of leasing or renting. As a result, there are many different ways of describing the concept. This report does not intend to 'settle the score' on what exactly is and what isn't PaaS but rather seeks to discuss the common concepts and how to enable them.

1.2 CREATING AND GETTING PAID FOR ADDITIONAL CUSTOMER VALUE

PaaS offerings have the potential to deliver multiple layers of additional customer value. The type of value PaaS delivers differs between customer segments (Business to Business (B2B), Business to Consumer (B2C) and Business to Government (B2G)). While PaaS offerings can provide financial and functional value to business customers, public sector customers and end consumers, the end consumers' purchasing decisions are more influenced by emotional and social values. For business and public customers, PaaS may also contribute to strategic value creation.

Examples of different types of customer value created by PaaS include:

Financial Value: As described above, PaaS allows customers to avoid upfront purchasing costs, reduce ownership costs, and distribute costs over time. This improves product affordability and may benefit the customers' financial health. These aspects are further enhanced when running costs such as maintenance, repair, and insurance are included in the offering. [25]

Functional Value: For both consumers, public organisations and businesses, opting for purchasing PaaS disconnects them from the responsibilities of ownership [26] [27] and can deliver higher flexibility according to changing customer needs (ie, by allowing the user to upgrade, extend, or cancel a subscription). For businesses, this can help reduce exposure to technology lock-in [28], where businesses invest a lot of resources in a specific technology making it highly expensive, difficult or time-consuming to switch or upgrade. It can also generate savings in resource inputs (eg, time, effort, or space) and improve the ease of use [29]. Another example of functional value is the provision of information or feedback to the user [14] [110] [116].

Emotional Value: PaaS can satisfy the customers' need to experience novelty and reduce boredom whilst disconnecting them from ownership responsibilities [25] [29] [18].

"By tracking our products with tracking chips, we can see where at our business customer's facility there are non-used products and collect them, thus, optimising our product flows"

- Thomas Eliasson, Finance Director,
Elis Textilservice

"By targeting customers that need our products but cannot financially afford their full price we can both fulfill their need to access a high-quality product and increase our PaaS sales"

- Martin Willers, Co-founder & CEO,
Transparent Sound


Social Value: For consumers, PaaS can also deliver value by fulfilling the consumer's need for status, image, or social interaction. For example, using an environmentally friendly product can give consumers the sense of belonging to an eco-conscious group and contribute to their specific image [25] [18].

Strategic Value: For business or public customers (B2B), PaaS can enable access to the provider's expertise. This can help the customer to optimise the usage of products and improve their operations [30]. PaaS can also increase customer focus on core activities and reduce the need for executing non-value-adding tasks [26] [17] [116]. For example, a manufacturing customer using electric motors-as-a-Service in its facility will have more time to focus on its core activities (manufacturing) since the provider will take care of the monitoring, service, and maintenance of the motors.



“By assessing the product’s condition, we can understand how our customers use our products and offer them feedback about more optimal use, to reduce product wear and thus, minimise the loss of valuable resources”

- Thomas Eliasson, Finance Director, Elis Textilservice



“By using our services, our customers save time and human resources that would otherwise be required to fulfil their needs”

- Joakim Hilding, Founder, Furnlease

Since the provider retains ownership of the product throughout the use cycle, revenue can be based on the value added and cost savings made along the way. The business logic for the provider will thus shift from maximising the number of sales, to focusing on delivering a specific result to the customer as efficiently as possible using its unique capabilities [16] [31]. This aligns the provider’s business objective with the actual needs of its customers.

Providers successfully transitioning to PaaS may reap substantial strategic benefit such as closer customer relationships, recurring revenue streams, and enhanced competitiveness for three main reasons. First, delivering a PaaS requires the provider to interact

and collaborate more closely with its customers. This enables the provider to better understand and respond to emerging customer needs, while also building stronger customer loyalty [32] [33].

Second, although shifting from one-off-product-sales to subscription or pay-per-use models can be challenging in the short to mid-term, it will make revenue streams more stable over several business cycles and enable the provider to capitalise on a broader span of services. Revenues from services also tend to have higher margins compared to sales of products [4].

Third, in a PaaS business model, companies build a competitive advantage based on service value [4], which by nature is difficult for competitors to replicate.

1.3 PRODUCT-AS-A-SERVICE IN PRACTICE

PaaS business models are not a new phenomenon, rather, they have been used by actors in the manufacturing industry to increase competitiveness for decades. One of the most prominent examples is Rolls-Royce Aerospace (RR Aerospace), which invented its PaaS model, “power-by-the-hour”, in 1962. Instead of purchasing a jet engine, the customer pays a fixed operational fee for the effective run time of their engines (ie, “up-time”) which includes installation, maintenance, repair, and decommissioning services [34]. To deliver on the value proposition, RR Aerospace expanded its capabilities from primarily manufacturing and installation to the real-time monitoring and lifecycle services needed to ensure the delivery of a high-quality and cost-effective service [35]. The shift in business model allowed RR Aerospace to improve the cost predictability and effectiveness of its customers’ operations while reaping substantial strategic and financial benefits. Examples include closer customer relationships by engaging in after-market support, increased capitalisation on products currently in use which in civil aircraft can be more than 10 times greater than annual sales [36], and a more stable cashflow since revenues from “up-time” are less cyclically sensitive than sales of jet engines [37]. It also allowed them to recover or recycle up to 95% of used engine parts, as components remain within their scope of control [38].

Another example is the machinery and equipment manufacturer Caterpillar. The company experienced low performing after-sale revenue due to the intrusion of 3rd party service providers and high availability of more affordable non-OEM spare parts in the market. This prompted the organisation to launch a new growth strategy where the company shifted its primary focus from products to services and customer outcomes [39]. In its rental offering, Caterpillar provides additional customer value by bundling access to machinery with service and technology which enhances productivity, precision, and worker safety. It also uses data to monitor equipment performance, make better design decisions and predict maintenance needs [40].

In recent years, fuelled partly by growing digital infrastructure and platform-based business models (see section 4.2), PaaS has been increasingly spreading to sectors and industries beyond manufacturing.

EXAMPLES OF PRODUCT-AS-A-SERVICE BUSINESS MODELS IN PRACTICE

Xerox, traditionally producing and selling photocopiers now specialises in value-added services. Xerox’s ‘managed print services’ contract enables business customers to focus on their core capabilities whilst outsourcing document management, installation, and configurations to Xerox. Using digital technology expertise, Xerox contributes to cost savings, improved productivity and security, and reduced paper waste and usage [33].

Tamturbo is selling compressed air-as-a-Service where customers pay for the amount of compressed air as measured by the airflow gauge. The new technology contributes to a 15% reduction in energy consumption and requires less maintenance than traditional solutions [88].

Trumpf’s “pay-per-part” business model allows customers to have a customised production process, access to use a highly effective laser cutting machine, as well as a maintenance package and service components. Its customers avoid the investment risk as well as expenses from unexpected downtime [93].

1.4 REWARDING SYSTEMIC COST REDUCTIONS

Lifetime product ownership by the PaaS provider enables the business to reap the financial value of circular economy adoption. This is because they will reap the financial benefits of cost reductions and efficiency occurring during all phases of the product lifecycle.

On a product level, there are three main dimensions of circularity [41] that are incentivised in the PaaS business model. These include:

- **Utilisation:** The intensity of how much or often a product is used.
- **Endurance:** How well the product retains its value throughout the lifecycle.
- **Recirculation:** The amount of a product's material and components which comes from a prior use phase or returns to another use phase.

Businesses operating a linear product-sales-oriented business model have no or low possibilities to create a business case for investments to improve these dimensions as the business primarily rewards number of products sold. For PaaS, the case is different (Exhibit 2).

PaaS pushes the provider to design products and operations to maximise utilisation as products only generate value when in use. Also, using as few products as possible (while still fulfilling customer needs) is key. Less products means less sourcing, manufacturing, operational and maintenance costs.

Providers will also invest in product design that supports high endurance, as longer lifetime and high-quality components also reduce sourcing, manufacturing and maintenance costs.

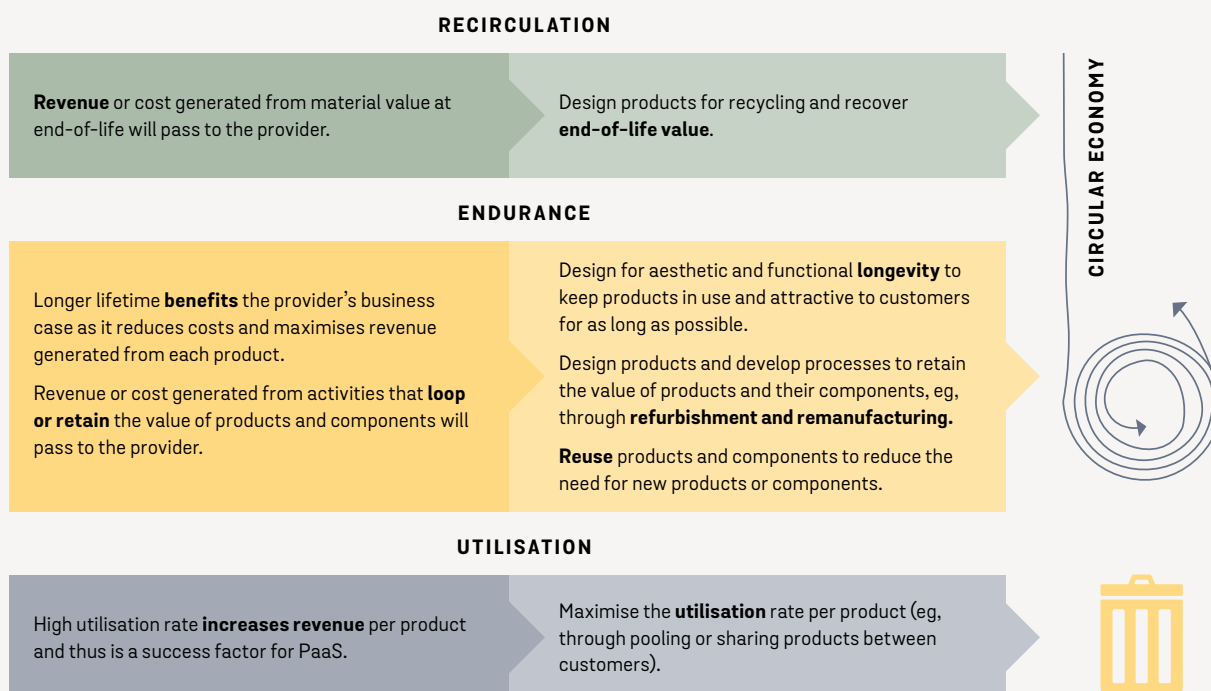
When product ownership is retained, revenue or costs generated at end-of-life (EoL) will pass to the provider. As a result, reuse of components and high-value recycling of materials is rewarded.

EXHIBIT 2: PRODUCT-AS-A-SERVICE AND THE CIRCULAR ECONOMY

Illustration showing how the PaaS business model rewards circular economy practices which improve the three dimensions of product circularity.

PAAS BUSINESS INCENTIVES

ACTIONS TO REALISE VALUE

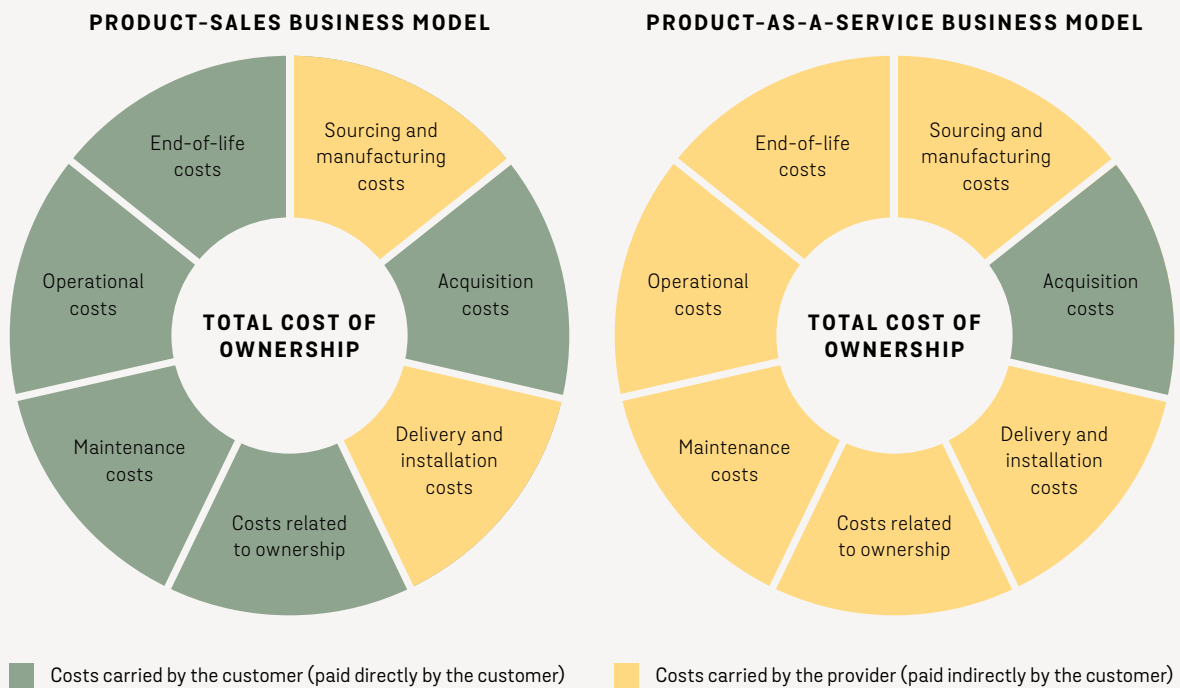


The reason PaaS business models are so critical to product circularity relates to the shifting of responsibility for cost categories that make up the Total Cost of Ownership (TCO). TCO includes all costs related to ownership, including purchase, use and disposal cost. When shifting from product sales to PaaS, costs associated with the use and EoL phases shift from the customer to the provider (Exhibit 3). As a

result, the provider now controls most of the TCO. This creates the opportunity to increase utilisation of products and reduce unnecessary consumption. Businesses can build capabilities to design and make products which last longer. And they have a new rationale to invest in operational efficiency.

EXHIBIT 3: ILLUSTRATION OF HOW COSTS SHIFT FROM THE CUSTOMER TO THE PROVIDER IN A PRODUCT-AS-A-SERVICE BUSINESS MODEL

Overview of costs carried by the provider in a product-sales business model and a PaaS business model. In the product-sales business model costs due to product failure, inefficiency or poor design will fall on the customer, while in the PaaS business model, these costs will fall on the provider.



Sourcing and manufacturing costs: sourcing, material, manufacturing costs and supplier margin.

Acquisition costs: administrative cost of acquiring the product.

Delivery and installation costs: transport, installation etc.

Costs related to ownership: stock management, depreciation costs, insurance etc.

Maintenance costs: spare parts, maintenance etc.

Operational costs: water, energy and fuel use etc.

End-of-life costs: recycling, disposal etc.

DEFINITION OF TCO AND LCC

Total cost of ownership (TCO) and lifecycle cost (LCC) are both used by organisations to inform purchasing decisions.

Total cost of ownership is the financial cost of purchase, use and disposal. The TCO is typically limited to costs incurred by a single market actor (the owner), hence it does not include external costs or costs borne by other actors [94].

Lifecycle cost is a closely related concept used to calculate all costs incurred over a product's lifecycle [87] [94]. In this report the LCC also includes the cost of social and/or environmental externalities (eg, healthcare costs or cost of greenhouse gas emissions).

Although PaaS providers are motivated to reduce costs which occur during the use EoL of a product, not all costs will decrease. On the contrary, some costs are likely to increase on a per-unit basis and new costs may be added as new activities are needed to execute the business model. For example, the need for a modular and high-quality product design that improves repairability, upgradability and longevity may increase manufacturing cost per unit. In addition, costs related to reverse logistics, maintenance and upgrades will likely be added.

To manage this increase in costs, PaaS providers need to actively strive to lower the total life cycle cost (LCC) of their products. In contrast to actors operating a traditional product-sales business model, they also have the means to do so. In a PaaS business model, the provider can extend the functional lifetime of products, use fewer products to deliver the same level of customer value, and improve operational efficiency to reduce running costs (Exhibit 4).

Imagine the case of a shared electric scooter. Designed to a solid, repairable and durable specification, the scooter can last longer. Less scooters are needed because the users share them. Running a tight ship in the collection and recharging operation, provides the opportunity to control costs further. These kinds of opportunities create the economic incentives for adopting circular economy strategies and generate the environmental benefits of PaaS. Less scooters per kilometer travelled means reduced emissions and

lower demand for raw materials [11] [15] [19]. Unfortunately, such benefits are not guaranteed. They depend greatly on whether an offering can fulfil customer needs with minimal material use and emissions [24]. In other words, the benefits of increased product utilisation will need to outweigh the environmental impact caused by PaaS operations, such as reconditioning, logistics, and maintenance [13].

To be competitive on the market, it is important that the financial benefits of reduced LCC are shared between the provider and the customer. In the perfect scenario, PaaS leads to a reduction of the TCO which benefits both the business and the customer (exhibit 5).

“The ownership of the products remains with the manufacturer or integrator who instead provides usership. This makes it possible to optimise the end of the use cycle of products, making them available to another user or in a new production cycle. The manufacturers we support are therefore starting to think in terms of circular design and reverse logistics. Users are no longer responsible for managing the products at end-of-life.”

- Yann Toutant, Founder and CEO, Black Winch - The As-A-Service Experts

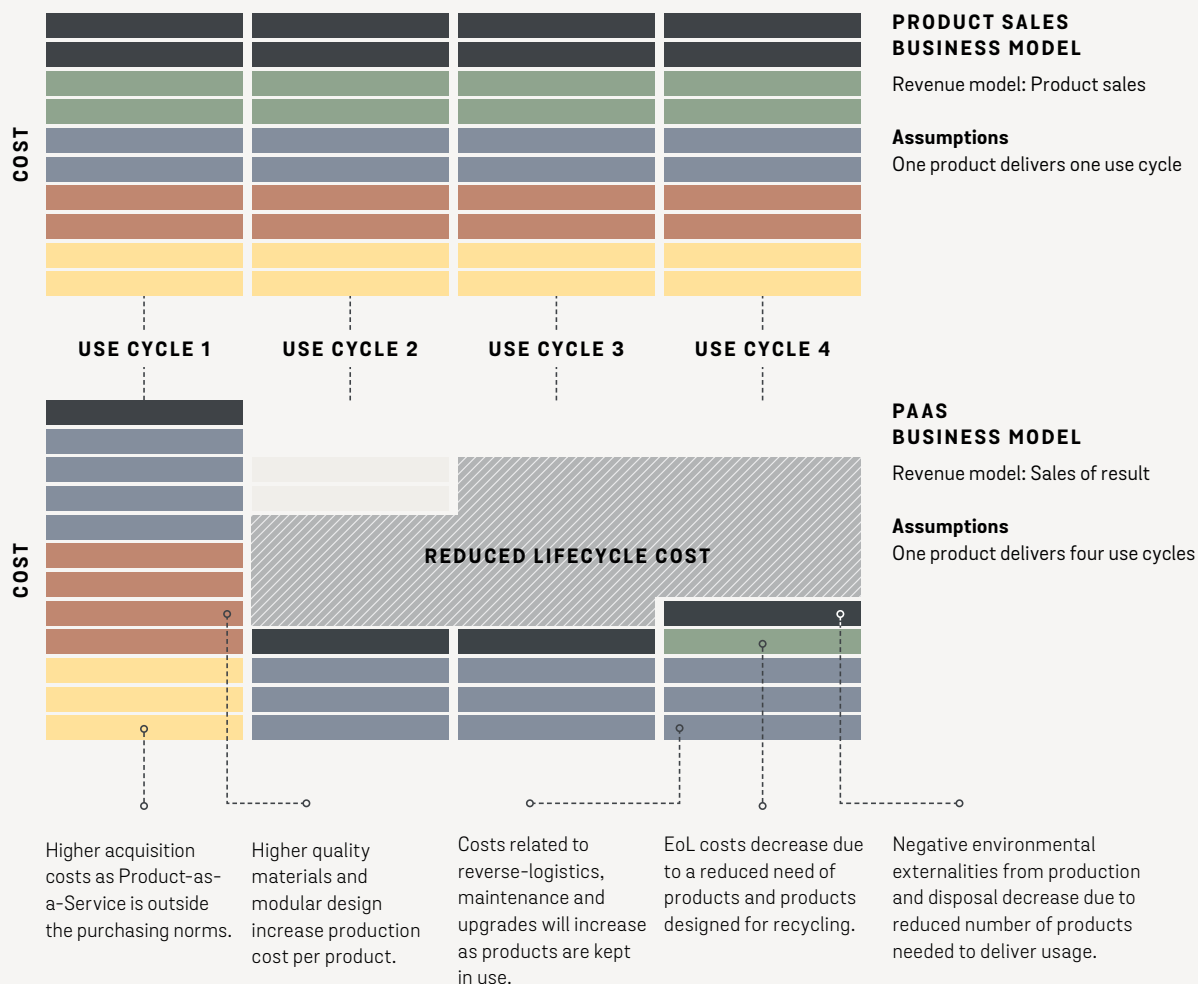
EXHIBIT 4: COMPARING TOTAL LIFECYCLE COST OF A PRODUCT-SALES AND A PRODUCT-AS-A-SERVICE BUSINESS MODEL

On the top we see four products needed to deliver four use cycles. There is four times the amount of material creating a lot of waste. On the bottom, we see one product being used effectively in four use cycles, giving rise to savings in materials, production costs and labour.

TOTAL LIFE CYCLE COST OVER FOUR USE CYCLES

EXPLANATION OF COST CHANGES

- Environmental and social externalities
- Sourcing, manufacturing, delivery and installation cost
- End-of-life cost
- Acquisition and non-quality costs
- Cost of ownership, maintenance and operation

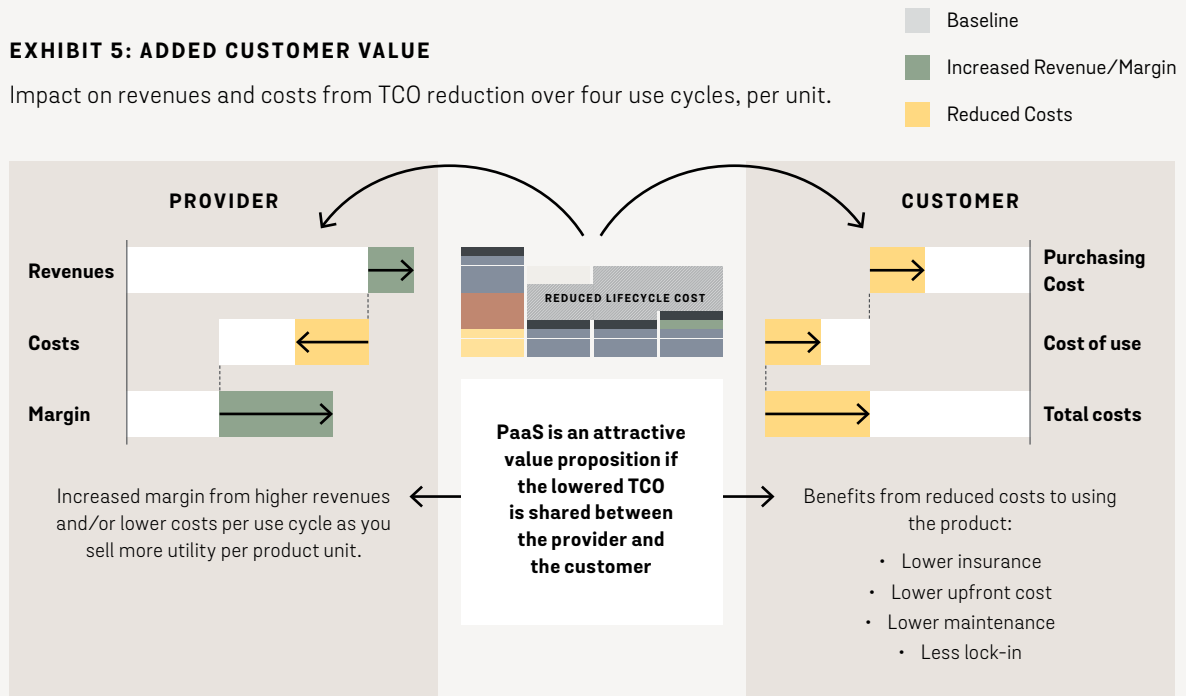


SYSTEMIQ [4] HAS CALCULATED THE POTENTIAL OF PAAS TO REDUCE CO₂-EMISSIONS AND TOTAL COST OF OWNERSHIP IN THREE SECTORS:

- **Equipment-as-a-Service for the manufacturing industry:** 37% reduction of CO₂ emissions and 16% reduction of TCO (Metal laser cutting machine)
- **Car-as-a-Service:** 25% reduction of CO₂ emissions and 2% reduction of TCO
- **White Goods-as-a-Service:** 24% reduction of CO₂ emissions and 18% reduction of TCO (Pay-per-wash)

EXHIBIT 5: ADDED CUSTOMER VALUE

Impact on revenues and costs from TCO reduction over four use cycles, per unit.



Despite spreading to an increasing number of sectors as businesses seek to reap these benefits, the uptake of PaaS in practice has not been as high as some might expect. This is due to several significant challenges businesses are facing, that will be discussed in the next chapter.

2. THE NINE CHALLENGES AND HOW TO FIX THEM

Despite the well-documented benefits and over a decade of active promotion, PaaS business models are yet to prove themselves at scale. Businesses face nine key challenges when launching and scaling their PaaS offerings. The challenges are found within customer acceptance, operational efficiency, and the financial risk of being an early mover. The challenges can be overcome by several actions. Businesses can adopt user-centred design processes. They can leverage new digital and data-driven technologies to reduce transaction costs, as well as costs of reversed logistics and predictive maintenance. Additionally, adopting efficient asset management and building a solid business case are crucial steps.

In this chapter, nine key challenges to PaaS adoption are identified. Each contributes to hindering PaaS uptake in the marketplace. This chapter also presents actions to address them for PaaS providers. The challenges are divided into three main categories, each containing three challenges. After each group of three, we present a range of actions that can be taken to remedy them.

The set of challenges faced by a business will, among other factors, depend on the sector, customer segment and product characteristics. While the challenges affect businesses of all sizes, challenges tend to be more difficult to overcome for SMEs due to their financial vulnerability and lack of access to relevant expertise in management, design, sustainability and other related areas [15] [14].

Note that this chapter presents challenges that can be addressed on a company level with the purpose of guiding SMEs in their launch of a PaaS business model. Institutional challenges are addressed briefly in chapter 4.

CATEGORY	CHALLENGE
Customer acceptance	<ol style="list-style-type: none"> 1. Customers like ownership 2. Customers underestimate the total cost of ownership 3. Transaction costs causes inconvenience
Operational and capability-related costs	<ol style="list-style-type: none"> 4. Increasing production costs 5. Lack of PaaS-specific capabilities 6. Immature ecosystem for partnerships
Financial risk	<ol style="list-style-type: none"> 7. Asset-heavy business model 8. Poor liquidity 9. Difficulty accessing capital

2.1 CUSTOMER ACCEPTANCE

PaaS offerings will compete with traditional product ownership offerings. Competing in the same market and challenging the norm, PaaS will need to deliver the same or improved function and value at an equal or better price compared with product ownership in order to gain customer acceptance.

CHALLENGES

The most critical challenges related to customer acceptance are the customer's preference for ownership, increased transaction costs such as booking a shared car or adjusting the saddle of a shared cycle, and an important tendency to underestimate what it actually costs to own something. B2C providers face the greatest challenges as customer behaviour is dominated by the prevailing pattern of private consumption [42]. Providers targeting B2B and B2G segments address a market which is familiar with numerous examples of successful PaaS business models [42], and are thus likely to face less challenges related to customer acceptance.

Challenge number 1: Customers like ownership

It is well-documented that changing customers' preference for owning a product, over having access to it, is a critical barrier for PaaS [43] [44] [1] [19] [115]. Product ownership is culturally embedded and difficult to challenge as it generates not only functional value, but also impacts social values such as status, image, and sense of control [28]. Customers have also been found to prefer product ownership due to the perception that reused and refurbished products are unclean or unreliable [45]. Moreover, customers tend to prefer products that appeal to their particular taste rather than uniform ones [44]. But product variability is more difficult to achieve in a PaaS offering. PaaS offerings must satisfy multiple users over time and therefore require a product design that is uniform, standardised, and insensitive to market trends. This limited product variability can lead to loss of customers for some PaaS providers that target specific B2C segments [16].



CUSTOMERS LIKE OWNERSHIP

Challenge number 2: Customers underestimate the total cost of ownership.

The B2C segment, in particular, has been found to significantly underestimate the total cost of product ownership (eg, costs associated with use, maintenance and depreciation) [46]. Lack of customer insight about the true TCO [28] is challenging as perceptions of what a product will cost, or how much could be saved, is the main factor that affects the willingness of customers to purchase a product [47]. This may cause the price of a PaaS offer, which already includes a large share of ownership costs, to appear as unreasonably high [28].

CUSTOMERS UNDERESTIMATE THE TOTAL COST OF OWNERSHIP



CONSUMERS SEVERELY UNDERESTIMATE THE TOTAL COST OF OWNERSHIP

A research team surveyed 6,000 citizens in Germany to assess to what extent consumers grasped the TCO of a car. Their findings suggest that people on average underestimate the TCO by $\approx 52\%$ or ≈ 2400 SEK/month. The main costs underestimated related to depreciation, repair, tax and insurance [46].

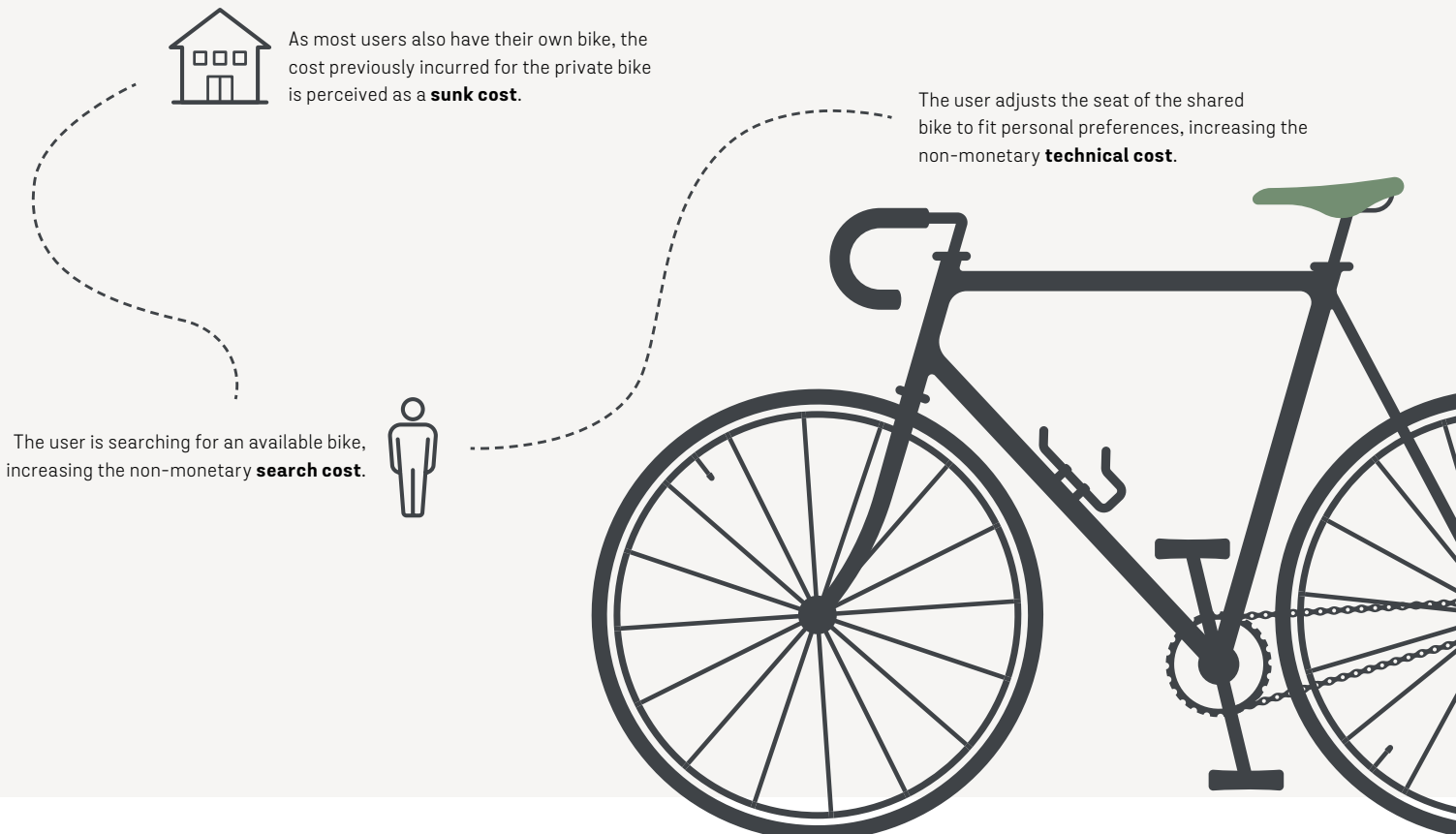
Challenge number 3: Transaction costs cause inconvenience

Apart from a recurring service fee, customers are likely to experience additional transaction costs (Exhibit 6), both monetary and non-monetary, when using PaaS. In a PaaS business model where a product is pooled between multiple users, these inconveniences can include the user having to identify, book, find, adapt, and adjust the product for every use, among a range of so-called search and technical costs (Exhibit 6) [43]. In addition, switching from product ownership to product access may instantly cause sunk costs for any previous investments that become irrelevant because of the switch. Consequently, PaaS providers need to be mindful of how their offers impact transaction costs compared with product ownership [43].



EXHIBIT 6: TRANSACTION COSTS

Example of how shifting from bike ownership to bike-as-a-Service increases a user's transaction cost [43]



ACTIONS

Providers can address the barriers and stimulate customer acceptance by really understanding customer needs, offering unique added value, exploding the myth that ownership is cheap, and exploring other market segments.

Really understand customer needs

Understanding the needs, values, habits, attitudes, and emotions of the target customer is a key to success for PaaS which challenges the norm of consumption. A business should therefore precisely identify these aspects and address them through the value proposition, [15] as well as design solutions that minimise obstacles to adoption of the offering by the customers [18].

Iteratively develop services with added value

This process requires a deep understanding of the customer needs (see above), since what qualifies as added value may vary greatly between different markets, product categories and customer segments. A general success factor is to involve potential customers in the development process of the offering to co-create value [48] and to iteratively test and adjust the value proposition according to customer feedback through several pilots [15][13].

Explode the myth that ownership is cheap

Reduced cost is a compelling argument for customers. Providers should therefore understand and calculate the true difference between the TCO for customers purchasing a product and the cost when choosing PaaS to address the same need. Including clear and fact-based information about costs and savings in sales and marketing helps customers understand the value proposition of a PaaS offer [116].

Explore other market segments

If and where possible and appropriate, providers of PaaS targeted to B2C may consider extending their offer to B2B and/or B2G customer segments. Here the barriers listed above are less prevalent and openness to PaaS may be higher [49]. For example, B2B and B2G segments tend to have lower requirements on product variability. This matches with what PaaS providers can offer as they typically provide more standardised products to facilitate efficient maintenance and repair. Targeting B2B and B2G segment is one strategy to minimise the plethora of customer needs that must be fulfilled by one product. This makes customer acceptance easier to reach [16]. Customers for whom the environmental benefits of PaaS generate added value can also be prioritised, such as organisations with a strongly stated sustainability agenda [11].

2.2 OPERATIONAL AND CAPABILITY-RELATED COSTS

Providers face challenges managing increasing operational costs when launching a PaaS business model. This challenge is amplified by the lack of key skills and capabilities, as well as an immature ecosystem for partnerships. Managing costs is especially challenging in the current economic environment, where PaaS providers face unsustainable competition from traditional product-sales businesses. These actors benefit from low-cost linear design and production processes optimised for high consumption.

The challenge of higher costs is most critical in the short- to mid-term during the launch of a PaaS business model. At this early stage, the provider must invest in new capabilities and products while adjusting to a distributed revenue stream [4]. In the longer term, financial stability may improve (Exhibit 7).

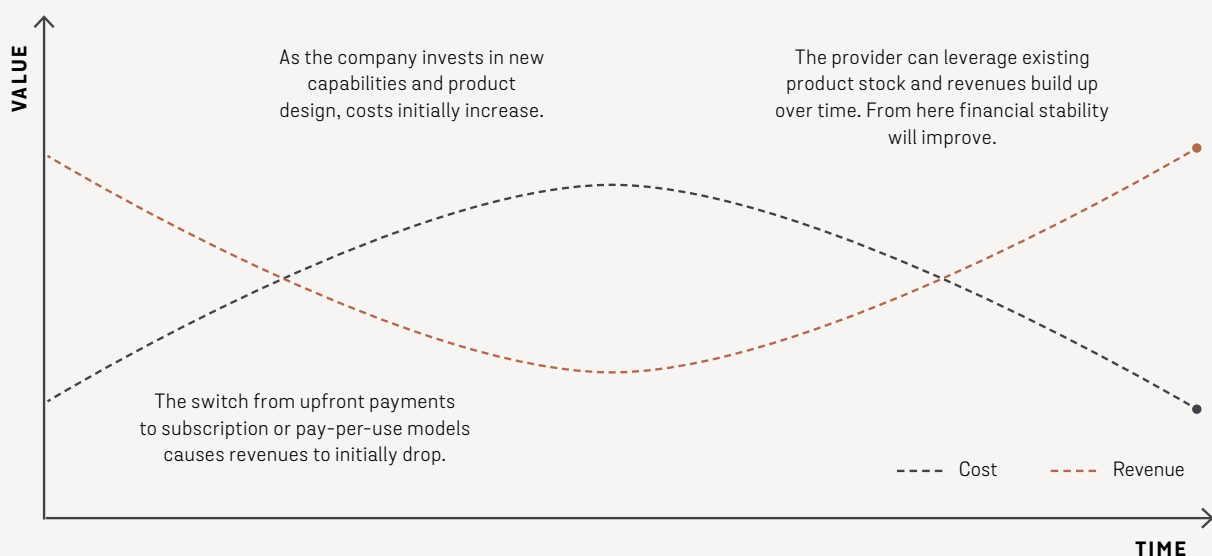
CHALLENGES

Challenge number 4: Increasing production costs

These often increase in the short-term for a product that is more durable, designed for high utilisation, and adapted to support cost-efficient maintenance [50]. While using high-quality materials and components is critical to reduce costs of operations in the long term, it typically requires a higher initial investment compared to linear products [11].



EXHIBIT 7: OVERVIEW OF HOW PRODUCT-AS-A-SERVICE IMPACTS REVENUE AND COSTS



Challenge number 5: Lack of PaaS-specific capabilities

Because of the low initial revenues and financing challenges, the operations of PaaS providers must be highly cost-effective. But a common challenge for PaaS providers is the lack of internal PaaS-specific capabilities leading to poorly planned execution, as follows.

- **Logistics:** In a PaaS business model, products may need to be pooled between users and returned for maintenance, reconditioning, repair, and refurbishment. However, the time during which a product is in transport or in maintenance must be minimised as the product only generates revenue when in use by the customer [16] [18]. At the same time, sending, receiving, and stocking products can create logistical challenges that drive costs and inhibit scaling of operations [44]. The difficulty of predicting

product flows to and from the customers, as well as the administrative burden, and geographic dispersion [51] [52] further increase the complexity of reverse logistics.

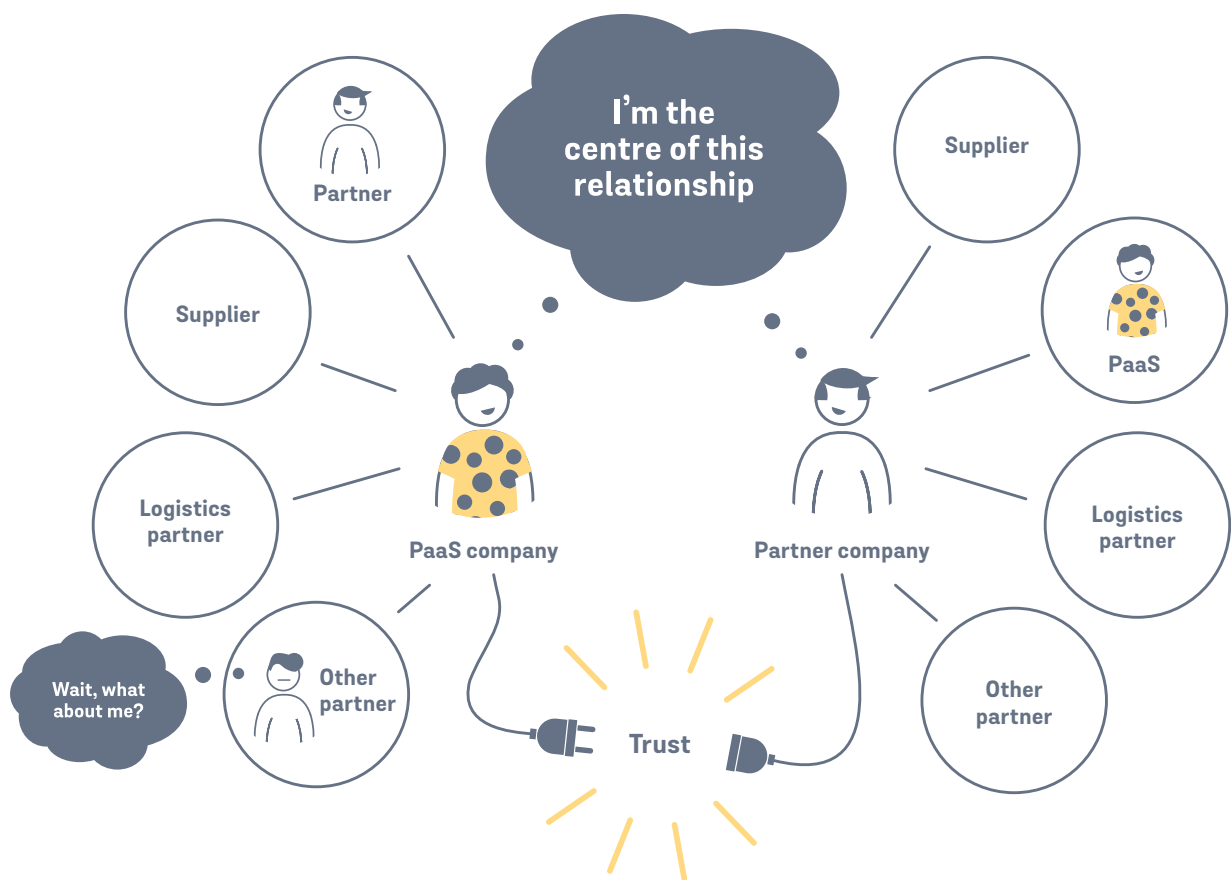
- **Marketing and sales:** Linear organisations launching a PaaS business model in parallel to common sales often fail to adjust their sales strategy to meet PaaS needs. Moreover, lacking knowledge of function or use-oriented sales and marketing, together with the use of traditional sales KPIs, disincentivises salespeople to sell and promote PaaS [19]. At the same time, new PaaS providers may lack the time or human resources to devote to marketing and sales. Both types of providers struggle with benchmarking the pricing of their offers [53] as the market of PaaS offers is still highly immature [17]. This can easily lead to reduced sales due to overpricing or loss of profits due to under-pricing.
- **Labour-intensive:** Activities that ensure products are maintained and recirculated, such as maintenance, repair and refurbishment, are labour-intensive and risk exceeding the financial savings of reduced production [51]. This is due to the relatively high cost of labour in relation to the cost of virgin materials needed to produce a new product.



Challenge number 6: Immature ecosystem for partnerships

PaaS providers often need to partner with value chain actors to execute their operations [1] [2] [11] [15] [16] [19]. However, the PaaS value chain is still highly immature. Thus, providers struggle to identify and engage the partners necessary for executing their business model. These include suppliers of green materials, logistical providers, refurbishment and reconditioning experts, recyclers [1] [2] [13], and

other PaaS providers. Collaborations with other PaaS providers are especially critical when such collaborations help create more appealing and holistic offers to customers [2] [16]. For example, a provider of home electronic equipment-as-a-Service may increase the attractiveness of its offer by bundling its PaaS with a provider of interior design solutions. In some cases, the needed collaborative partners are simply absent on the market because PaaS offerings are still a limited phenomenon in many sectors [1].



IMMATURE ECOSYSTEM FOR PARTNERSHIPS

ACTIONS

To best manage PaaS operations, it is essential that providers adopt strategies that reduce the impact of high production and capability-related costs. These include optimising operational processes, building a devoted PaaS-team, and adjusting goals and metrics.

Optimise operational processes

- **Design operational processes to maximise product utilisation.** Having well-planned operational processes in place before launching the business model is critical [18]. Plan processes such as logistics, storage, reconditioning, and refurbishment to support maximum utilisation to increase revenue and reduce cost. Ensure the product is designed for efficient maintenance and repair by using modular composition and high-quality materials.
- **Leverage digital and data-driven technologies in operations and administration.** Use digital tools that enable efficient planning and management of assets and complex processes such as customer management, logistics, and stock management [14] [17] [15]. Being able to digitally track the products by, for example, tracking chips or RFID codes, is of special importance when it comes to stock management and data collection and analysis [14] [16] [17] [18]. To digitally collect information on product use and condition is also critical to identifying opportunities to improve the efficiency of operations [10], as well as to reducing administrative burden.
- **Outsource activities and build partnerships.** Search for external collaborative partners that can bridge internal competence gaps and missing

capabilities. Activities that are commonly outsourced include digital solutions, production, marketing, logistics and refurbishment. Outsourcing of such activities to specialised partners enables providers to focus on their core business [13] [11] [10] [15] and scale operations [1] [2] [16] [15]. Success factors for building partnerships are found in exhibit 8.

- **Target high-value customer segments.** If possible, providers may reduce their operational costs by targeting customers that generate higher value sales which, in turn, may reduce the operational costs related to administration, transportation, and reverse logistics per transaction. Examples include B2B and B2G customer segments.

Build a devoted PaaS team

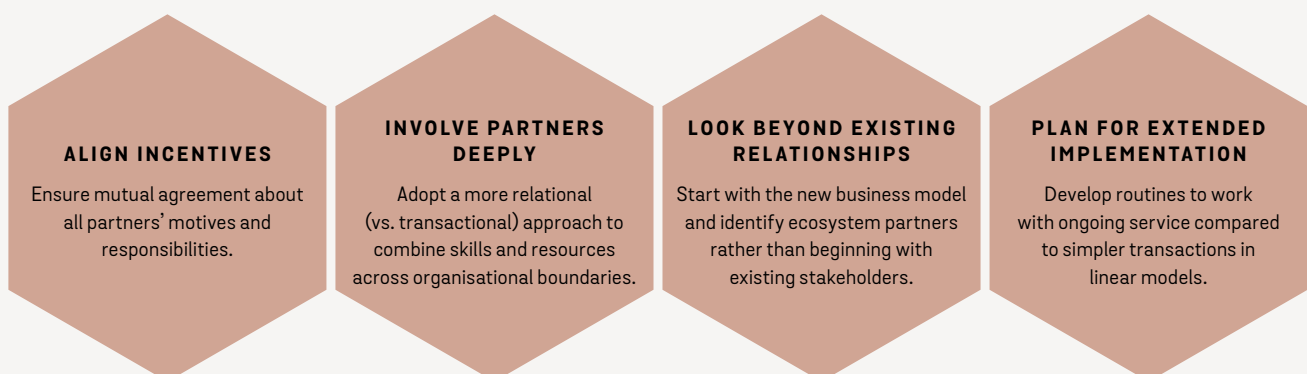
Businesses often underestimate the impact launching a PaaS will have on business operations compared with traditional sales of products. Providers should therefore enable the accumulation of internal knowledge and capabilities by establishing a team with the mandate to develop PaaS processes and operations. This is especially relevant in cases where a company is undergoing a PaaS development journey in parallel to running traditional product sales [10].

Adjust goals and metrics

It is critical that goals and metrics (KPIs or similar) for PaaS sales are adjusted to reflect, and thus incentivise, the sales of services rather than the sales of products [19] [11]. Educating salespeople on PaaS-specific selling can prove beneficial as well [15] [10].

EXHIBIT 8: FOUR KEY ELEMENTS FOR BUILDING SUCCESSFUL PARTNERSHIPS [42]

PaaS providers should explore opportunities for entering long-term, mutually beneficial relationships, and involve partners deeply.



2.3 FINANCIAL RISK

PaaS business models require large initial investments in assets, which in some cases may account for a substantial part of the provider's available capital. This is because the provider retains product ownership and offers a combined service and product solution to the customer. Moreover, as products are not sold, the provider is not receiving a payment equal to the full value of the product at the point of sale, as is the case with traditional sales. Instead, the provider's revenues are distributed over time as the customers only pay a small amount per period (eg, a monthly subscription fee or a fee per time of use). This, in turn, can lead to poor financial performance for PaaS providers compared to linear competitors in the short term, giving rise to various financial challenges.

CHALLENGES

PaaS providers experience three critical challenges related to financial risk that include being asset-heavy, having poor liquidity and experiencing difficulties accessing capital.

Challenge number 7: Asset-heavy business model

Retaining product ownership implies high fixed costs for a PaaS provider, which becomes "asset-heavy". This impacts a company's ability to be agile and respond to rapid changes in its environment, such as changing market demand, technology advancements and new market opportunities. "Asset-heavy" companies rely

on revenues to cover those costs, whereas costs for "asset-light" companies are variable relative to their revenues, leading to less volatile profits [54]. Although asset-light companies have been found to achieve a greater total shareholder return across sectors, asset-heavy business models can still be high-performing [55].



EXAMPLES OF ASSET-LIGHT AND ASSET-HEAVY COMPANIES IN THE HOSPITALITY SECTOR

Asset-heavy: Hotels are typical example of "asset-heavy" companies. They have high fixed costs such as construction or acquisition, as well as operation, maintenance, and staffing. To cover those costs, providers must continuously generate revenues by utilising their assets. As a result of the Covid-19 pandemic, hotels across all segments adopted strong measures to stay in business, decreasing their prices by 20-40%. [91]

Asset-light: Airbnb is an "asset-light" company as its costs vary depending on revenues. Its profits are therefore less volatile. During the pandemic, the prices of Airbnb listings had a significantly lower decline of 9%. [91]

Challenge number 8: Poor liquidity

PaaS providers are likely to struggle with poor liquidity (ie, availability of cash) in the short to medium-term after launching their business model, due to the combination of distributed revenues and high upfront investments needed to build a product stock and launch new business operations [11] [17] [16] [56] . The provider may therefore struggle with covering capital costs during the first operating years of a PaaS [44]. To stay afloat, providers may need a longer payback period on loans or investments compared with a traditional retailer, which in turn risks leading to higher total investment costs due to higher interest rates.

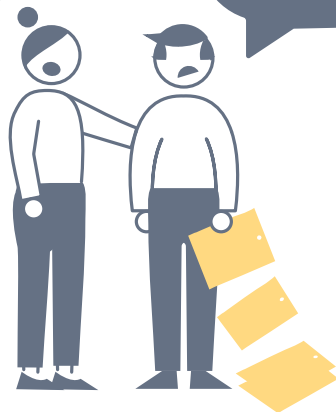
“It takes time to generate cash in the short-term as the PaaS business model is slow and profits first come from cost-efficiency and scaling-up. This has made it important for us to work with a slim organisation to keep costs down”

- Fredrik Karlberg, Founder, Jonna AB

All our products are in use now and the money will come in over the next five years

But we have all these bills to pay now!

POOR LIQUIDITY



LIQUIDITY CHALLENGES FOR A PAAS PROVIDER COMPARED TO A TRADITIONAL RETAILER

Traditional product sales: A bicycle retailer will stock a small number of bicycles at a time and get paid the full value of the product at the point of sale, and thus generate the revenue needed to pay back the supplier and pay salaries and loans etc.

Product-as-a-Service: A provider of bicycles with monthly subscription will need a higher initial investment to build a stock of a sufficient number of bicycles to be able to immediately respond to the market demand. The full value of the product will not be paid at the point of sale (ie, when instead a subscription contract is signed), leading to lower revenue generation rate in the short-term and a lower capacity to compensate for the initial investments.

Challenge number 9: Difficulty accessing capital

The current financial system assesses the performance and profitability of a business based on traditional financial indicators designed for linear business models. As mentioned above, a PaaS business will likely experience initial high investments and low revenues. These financial characteristics may be assessed as “of high risk” when using traditional financial indicators, making a business less attractive to investors [18].

Moreover, the assets of a PaaS business are not always accepted by financiers as collateral (ie, security for repayment of a loan), especially if they are of low value or if their residual value is unpredictable [18] [57]. This makes it likely that a PaaS provider will struggle more to access external capital from financiers or investors when compared with a traditional retailer [11, 12, 14, 18, 111]. As a further consequence, limited external capital may cause businesses to struggle with the scaling of their operations [11].

“It is hard to attract traditional investors with a PaaS business model as they may ask for a 20-fold profit in 10 years. So, we need to target investors that not only value the potential to make a high financial return in the short-term, but also strive to have an impact on sustainability”

- David Knutsson, Founder, Parently



HOW PaaS BUSINESSES WILL RATE AS INSECURE WHEN TRADITIONAL FINANCIAL RATIOS ARE USED

Net income: Measures the extent to which revenue exceeds a firm's expenses. The measure may be lower for PaaS, as incomes are distributed over time while cost (in the short to mid-term) may increase. Example of function: $\text{Net income} = \text{Gross income} - \text{expenses (eg, labour and interest payments etc.)}$.

Efficiency ratios: Measures a firm's ability to effectively employ its resources, such as capital and assets, to produce income. Several ratios exist. Example of function: $\text{Efficiency ratio} = \text{Asset turnover ratio} * \text{net sales} / \text{average total assets}$ [85].

The range of a "good" efficiency ratio varies between industries, but the higher the asset turnover ratio the more productive a firm is considered. For asset-heavy firms with

distributed revenue flow, the risk of a low asset turnover ratio is significant [85].

Solvency ratios measures a firm's ability to meet its long-term debts and obligations. It analyses the actual cash flow (including non-cash expenses such as depreciation) versus liability. Solvency ratios vary between industries and multiple ratios exist [86]. Example of function: $\text{Solvency ratio} = \text{Interest coverage ratio} * \text{EBIT (earnings before interest and tax)} / \text{interest expenses}$.

The interest coverage ratio measures the number of times a firm can cover its interest payment with its available earnings. The higher the ratio, the better [86]. For businesses offering PaaS, it may be difficult to achieve a high ratio in the short- to mid-term, due to distributed revenue streams and high-upfront investments.

ACTIONS

To mitigate the financial challenges associated with a PaaS business model, providers can work with efficient asset management, shift to PaaS gradually and develop a solid business case to help access capital.

Adopt efficient asset management

A PaaS provider can employ different strategies to improve the efficiency of asset management. First, the provider should strive to continuously improve processes to operate, monitor, maintain, upgrade and dispose of assets in the most cost-efficient manner. This can be achieved by using an asset management platform [110]. Efficient asset management also requires the provider to maximise product utilisation, as products only generate revenue when in use [16] [17] [18].

Second, limiting asset ownership can also mitigate the financial risks of being "asset-heavy" and improve the balance sheet. This can be achieved by leasing products directly from a producer [12] or by using a sale-lease-back arrangement in which the provider sells its assets and then leases them back from the purchaser [58]. Such an arrangement may relieve the provider from the burden of asset ownership while generating capital [111].

Third, the provider may also focus its activities on its core capabilities [55] while outsourcing activities that are beyond the organisation's expertise or require high investments, such as logistics and IT solutions. This way, the provider may reap some of the benefits associated with asset-light companies (Exhibit 9).

DEFINITION OF SALE-LEASEBACK ARRANGEMENTS

Sale-leaseback is a financial arrangement that allows providers to utilise the cash they invested in an asset (eg, their products), while still using the asset to operate their business. In such an arrangement, a company (lessee) can sell its assets to a purchaser (lessor), thus improving cash inflow, and then lease the assets from the purchaser (thus being able to use the assets). This arrangement not only offers access to capital, but also relieves a provider from the risk of being assessed as “asset-heavy” [92]. Utilising a sale-leaseback arrangement (or leasing in general) is often preferred by businesses over using equity to purchase goods, where the return requirements are much higher. Sale leaseback can allow a company to be more efficient with its cash, not dilute equity unnecessarily and invest elsewhere where there is more impact to core business, eg, marketing or technology development. One example of a sale-leaseback arrangement in practice is a Bicycle-as-a-Service provider who sells its bicycle fleet to a purchaser and then leases the bicycles back [11].

EXHIBIT 9: THE BENEFITS OF GOING ASSET-LIGHT [55] [59]

An asset-light strategy is about focusing a firm’s activities on its core capabilities and assets. That requires partnerships with organisations that deliver the additional capabilities necessary to execute the business model.



Shift to PaaS gradually. A key strategy to avoid poor liquidity is to launch or transit to PaaS gradually rather than aiming for a full-scale shift [15]. For example, incremental development (eg, piloting the business model in close collaboration with various customer segments and stakeholders) and gradual scaling allows the provider to keep control over its capital while adjusting and validating the business model. This also reduces the exposure to short- to mid-term risks, such as an uneven cash flow. In the longer term, financial stability may improve as revenues build-up and the loan-to-value (LTV) ratio (a measure comparing the amount of debt with the value of the assets) decreases as the product stock is paid off. For actors running a PaaS in parallel to their traditional business model, separating the financial results of those two is one way to explain the impact of PaaS on the balance sheet to investors and loan providers [13].

Build a solid business case. As PaaS business models risk being rated as less viable than traditional product-sales business models, providers need to clearly communicate the mechanisms of value creation in their business model (eg, that it enables value capture from multiple use-cycles) [18] and build a detailed business case based on tangible metrics [18].

Relevant metrics include estimations that support the valuation of assets, such as forecasted revenues or product quality and condition, display the effective utilisation of products, and demonstrate customer retention. The latter can be achieved by measuring churn rate (ie, the number of cancelled subscriptions during a certain period) [18] [11] [15] [12]. Other PaaS-specific advantages include lower exposure to supply chain disruption and increased cross-selling opportunities to customers [14]. Ensure these advantages are adequately described and quantified.

Moreover, it is important for providers to carefully consider what type of collateral to use to serve as security for loans. If assets will be used, measures that support the valuation of these assets and demonstrate their residual value (eg, by sourcing market data and benchmarking) [18] can substantially improve the likeliness of those assets being accepted as collateral [12] [57].

The provider can increase the products' residual value by keeping them operating at peak condition (eg, through preventive maintenance) which may lower their depreciation rate [60]. Assets should preferably also be standardised, durable, moveable, and not too geographically dispersed [57]. This will guarantee that the financier can easily collect the products, sell them in bulk, and recover value in case a provider is unable to pay off a loan. In other cases, long-term service contracts may be preferred as collateral [12] if they are signed with creditworthy customers, although this is less feasible for businesses using a pay-per-use pricing model [57].

PART 2

Taking action

3. A METHODOLOGY FOR SPEEDING UP THE ADOPTION OF PAAS BUSINESS MODELS

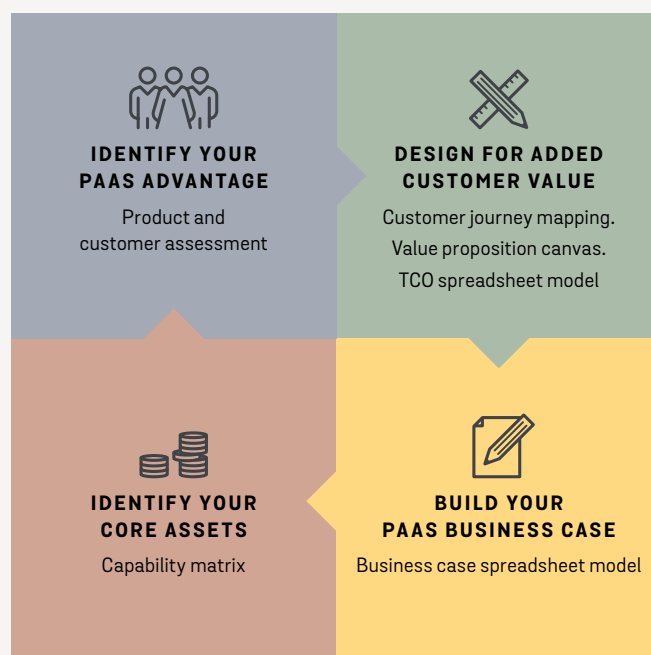
Practitioners can take actions to avoid common pitfalls when designing their business models. The four-part methodology equips you to design offers that are appealing to customers by helping you assess your product and customer segment’s compatibility with PaaS, to understand your customer, and to calculate your customer’s TCO. It also helps you test the value potential of your business model, guide your selection of a pricing model, and map out which assets and capabilities are strategic to develop internally, and which should be developed through partnerships or outsourcing to external actors. This helps you address challenges related to both operational and capability-related cost and financial risk.

This chapter presents a methodology to better equip businesses for a PaaS transition. The tools included build upon existing business strategy tools modified to fit a PaaS context and enable businesses to address the identified challenges. The methodology is a prototype and will be piloted and improved in the next phase of the project (September 2022 – May 2023). It includes tools to help businesses do two things:

- Assess the potential and feasibility of a PaaS business model in their business context.
- Avoid or manage the most crucial challenges identified in Chapter 2.

This chapter, and the included methodology, is created with PaaS practitioners in mind. It speaks directly to business stakeholders that have implemented, are working on, or are considering launching a PaaS business model. Others are welcome to read on too, of course, and could use this chapter as a reference point when trying to support the acceleration of PaaS in the economy. Note that the methodology is not a complete toolbox for the development and implementation of a PaaS business model. Neither does it cover all the identified challenges in Chapter 2 (for which potential actions have been identified). Rather, it should be seen as a starting point that helps businesses design a PaaS business model while avoiding common pitfalls.

EXHIBIT 10: OVERVIEW OF THE METHODOLOGY



The methodology is divided into four parts (Exhibit 10). In each part, you will find one or several tools. Practitioners can choose to pursue each part sequentially or start with the tools that fit their current needs. The development of a PaaS business model will require several iterations, so you will benefit from revisiting the different tools during the development process.

- **Identify your PaaS advantage** includes a list of advantageous and more challenging product characteristics and customer segments to guide you in the decision of what and who to target. In this step, you will assess the suitability of your product and customer segment for a PaaS business and ideate on how you can address potential challenges.
- **Design for added customer value** includes customer journey mapping for a traditional product-sales business model and a PaaS business model, as well as a PaaS value toolkit to help you identify how to create additional customer value through PaaS. It also includes an adapted value proposition canvas and a TCO calculation – two crucial tools to pin down the added value of a PaaS model. In this step, you will deepen your understanding of customer gains, pain points, and requirements. You will also build an attractive value proposition and map out which activities are required to operate the business model.
- **Build the PaaS business case** includes a spreadsheet tool to help you calculate KPIs, estimate the business break-even point, utilisation rate and customer base, and project future cash flow. In this step, you will assess the viability of the business model, choose a revenue model, and prepare the delivery of a solid business case to external investors.
- **Identify your core assets** includes a strategic capability assessment to help you assess the capabilities needed to execute your PaaS business model. This capability matrix helps you identify which capabilities are core to your organisation and/or a competitive advantage, and should therefore be kept internal, and which should be outsourced to external partners for efficiency.

3.1 IDENTIFY YOUR PRODUCT-AS-A-SERVICE ADVANTAGE

PaaS business models are more suitable for some product and customer segments, which makes it important to carefully consider what and who to target. At this stage of the method, you will assess how your product and future PaaS offering relate to the identified product and customer segment characteristics that make PaaS more or less challenging to implement. In an environment where PaaS is still far from mainstream, it makes sense to identify potential challenges early, and explore their potential to be addressed through eg, changes in product design, product segment, or customer segment.

1. Product characteristics

The characteristics of your product will impact the viability of a PaaS business model. In general, cheap, consumable, and personal products are less suitable for PaaS than expensive, durable, and non-personal products. There are, however, grey zones. One example are product segments with rapid technology development (eg smartphones), which have traditionally been considered less suitable for PaaS as products quickly become obsolete [61]. Yet, examples show that PaaS can be feasible for such products as well as in cases where the provider offers hardware and software upgrades to counter fast obsolescence and reuse components [62].

Products included in a PaaS offering should be carefully selected. The table below lists advantageous and more challenging product characteristics. The table is to be used as an assessment form to help you evaluate the PaaS potential of your product. Far from all advantageous product characteristics must be present in a successful PaaS offering, but if a lot of them are missing you may consider choosing a different product. Alternatively, more time spent assessing which challenging product characteristics need to be addressed may be warranted. The goal is to ensure the offering can still be made attractive to customers. This may include changes in product design or development of added services.

TABLE 2: EVALUATE YOUR PRODUCT’S “AS-A-SERVICE” POTENTIAL

	ADVANTAGEOUS PRODUCT CHARACTERISTICS	CHALLENGING PRODUCT CHARACTERISTICS	DESCRIPTION
COST AND VALUE	Expensive	Cheap	High-value products are more likely to generate the revenue needed to finance service delivery [61]. Customers are also more likely to be willing to pay for accessing products they cannot afford or pay full price for [115].
	High complexity and/or cost of maintenance and repair	Low complexity and/or cost of maintenance and repair	The provider can deliver added value through its capabilities in maintenance and repair [61] [63].
	Use-phase resource inputs (eg, fuel, water, energy) constitute considerable part of TCO	Use-phase resource inputs constitute minimal part of TCO	The provider is better positioned to reduce use-related costs and thus reduce the customer’s TCO [61] [63].
	Infrequently used (can be shared with several users during the same product lifecycle)	Frequently used (more difficult to share between more than one user)	Only paying for what you use becomes attractive if there is a large difference between ownership time and actual use time [64].
	High material value after use	Low material value after use	Higher material value enables the provider to capture financial value from reusing, recycling, or remanufacturing of components and materials [61].
	High insurance cost	Low insurance cost	Higher cost of ownership makes PaaS more compelling to customers.
PRODUCT DESIGN	Durable	Consumable	Products that last for several reoccurring use-cycles are generally a better fit for PaaS [61].
	Low emotional involvement	High emotional involvement	Customers are more prone to prefer owning status or identity products, especially customised ones with high emotional attachment [61].
PRODUCT FEATURE	Non-personal	Personal (eg, privacy, hygiene, or smartphone)	Workhorse products contribute little or none to users’ sense of self or expression of personality (eg, washing machine) and could feel less crucial to own, while customers often prefer owning highly personal products [61].
	Modular product design	Non-modular product design	The provider can better reap the long-term benefits of PaaS if a product has a modular design, is easy to dis- and reassemble and fit for repair, upgrades, refurbishment, and remanufacturing [62] [64].
	Smart integrated product	Analogue product	Smart integrated products enable the utilisation of data to provide insights on product use and deliver added value to the customer [62].

TABLE 3: PRODUCT ASSESSMENT EXAMPLES

Table 3 shows four products and an assessment for each one. The circles represent advantageous, disadvantageous or intermediate product characteristics. A discussion of each use-case follows on page 49.

PRODUCT CHARACTERISTICS		PRODUCT ASSESSMENT			
ADVANTAGEOUS	CHALLENGING	Philips "MRI scan-as-a-Service"	Jonna AB "Bicycle-as-a-Service"	Rolls-Royce "Engine-as-a-Service"	Foxway "Laptop-as-a-Service"
Expensive	Cheap	●	●	●	●
Durable	Consumable	●	●	●	●
High complexity and/or cost of maintenance and repair	Low complexity and/or cost of maintenance and repair	●	●	●	●
Resource inputs constitute considerable part of TCO	Resource inputs constitute minimal part of TCO	●	●	●	●
Infrequently used	Frequently used	●	●	●	●
High material value after use	Low material value after use	●	●	●	●
High insurance cost	Low insurance cost	●	●	●	●
Low emotional involvement	High emotional involvement	●	●	●	●
Non-personal	Personal	●	●	●	●
Modular product design	Non-modular product design	●	●	●	●
Smart integrated product	Analogue product	●	●	●	●

- Challenging
- Advantageous
- Intermediate

EXAMPLES OF PRODUCT ASSESSMENTS

Philips: MRI scan-as-a-Service

Philips offer medical equipment, in this case the MRI scan machine, through a pay-per-scan/pay-per-patient model [99] [100]. The product matches most of the listed advantageous characteristics except for modularity and frequency. Frequency of usage may be either low or high depending on the number of patients.

Jonna AB: Bicycle-as-a-Service

Jonna AB offers bicycles by subscription. A bicycle falls on the challenging side based on its intermediate difficulty to repair and maintain, low insurance cost and that it is an analogue product used for personal purposes. Considering emotional involvement and the expression of personality, these aspects depend on the type of customer targeted. A bicycle is however a durable and modular product, allowing Jonna AB to repair the products and retain them in use for a longer time period. The bicycle matches far from all the advantageous characteristics, exemplifying how, despite this, products can still form the basis of a PaaS offering if the business model and service offering are carefully designed to fulfil a user's needs.

Rolls-Royce: Engine-as-a-Service

Rolls-Royce is often used as an example of PaaS in practice which demonstrates the benefits and advantages of the business model. When applied to the product characteristics table, its engine matches all except one product characteristic (infrequently used) that makes PaaS advantageous. It's expensive, durable, has a high complexity of maintenance, is supportive of other tasks, and is a smart integrated product, to mention a few.

Foxway: Laptop-as-a-Service

Foxway offers refurbished laptops-as-a-Service to B2B customers. Laptops are expected to have a medium to high value and durability, with a relatively high complexity of maintenance and repair. At the EoL, laptops or their components (eg, hard drives and processors) can be refurbished and reused or recycled, thus giving Foxway an incentive to retain product ownership and prolong their lifetime. Laptops in a business context are expected to be associated with limited emotional value, making them appealing candidates for PaaS. Foxway can also deliver added customer value leveraging use data and device health status, for example by identifying and relieving the customer of unused devices, which reduces the customer's costs.

2. Customer segment

The choice of customer segment will impact how to design your operations and activities. Generally speaking, PaaS offerings are more likely to be considered attractive by B2B or B2G customer segments, whereas implementation in more trend-sensitive and more immature B2C segments is often challenging [5] [11]. The reason is that PaaS offerings are already more common in a B2B and B2G context [42], where they are associated with higher value contracts [61], and where the customers tend to have better knowledge of their TCO. Targeting B2C segments is still feasible but likely to require highly cost-efficient operations owing to the larger number of smaller transactions which risks to

increase the administrative and logistical burden [61]. Additionally, a very clear value proposition is important as PaaS tend to be in stark contrast to the dominant pattern of private consumption [28]. Here, digitalisation offers opportunities to open up B2C segments through highly efficient (and potentially automated) systems to handle administration and logistics, as well as customer relations.

To help you take an informed decision about the customer segment, you can use Table 4 below to assess your potential to execute your business model given the different characteristics of each customer segment.

Hint!

If you identify any challenges when thinking about these questions, can you think of ways to work around them?

Perhaps your organisation can build new capabilities or invest in technologies to support efficient administration etc.?

TABLE 4: CUSTOMER SEGMENT ASSESSMENT

QUESTION	GUIDANCE	A	B
Do you need to spend significant resources on building close customer relationships and getting customers to understand your value proposition?	Spending significant human and/or financial resources on customer relationships and interactions (eg face-to-face meetings or other types of close personalised communication) is more feasible if you have a larger buyer (more common for B2B/B2G).	Yes	No
Do you need to customise your PaaS offering to each customer?	Customising an offer to fit the specific need of a customer, which can be both time and resource-consuming, is more viable if you have a larger buyer (more common for B2B/B2G).	Yes	No
Do you have the capabilities to handle many low-value transactions efficiently?	As B2C is associated with many low value transactions, they can increase administrative burden unless handled efficiently using eg, automation and digital technologies.	No	Yes
Is your organisation digitally matured, ie, can you automatise administration, customer relations, and logistic flows?	Digital maturity will help when designing all types of offerings, but are critical for B2C segments as operations, administration, and sales need to be highly cost-efficient.	No	Yes
Is your customer and/or end-user (depending on who you will interact the most with) likely to have a high digital maturity?	A low digital maturity amongst your customer and/or end-user may make it difficult to improve efficiency in sales and operations. Spending human and/or financial resources on customer relationships is more feasible if you have large buyers which provides a single point of contract, less geographic dispersion, and higher sales volume (more common for B2B/B2G).	No	Yes

Did you mostly answer A? Then targeting B2B and/or B2G segments is likely most suitable.

Did you mostly answer B? Then the potential is high for your business model to fit all segments your offering is relevant to.

3.2 DESIGN FOR ADDED CUSTOMER VALUE

Designing a compelling PaaS offering to customers

requires a deep understanding of their needs, pain points and requirements. The importance of a clear value proposition is stressed by interviewees stating that customers often have a difficulty to understand what is included, or not, in a service offering [116] [118]. This part of the methodology kit incorporates three different tools: customer journey mapping [65], value proposition canvas and TCO calculation. They are all tools to revisit and develop iteratively as you gain more insights.

Step 1: Customer profile

Define the customer’s jobs-to-be-done, ie, the core need and/or problem to solve. This can be expressed as a functional unit (eg, X m² grass cut/month).

Step 2: Customer journey mapping: Baseline

Map out a baseline customer journey. This can be your current offer or the dominant way in which customers

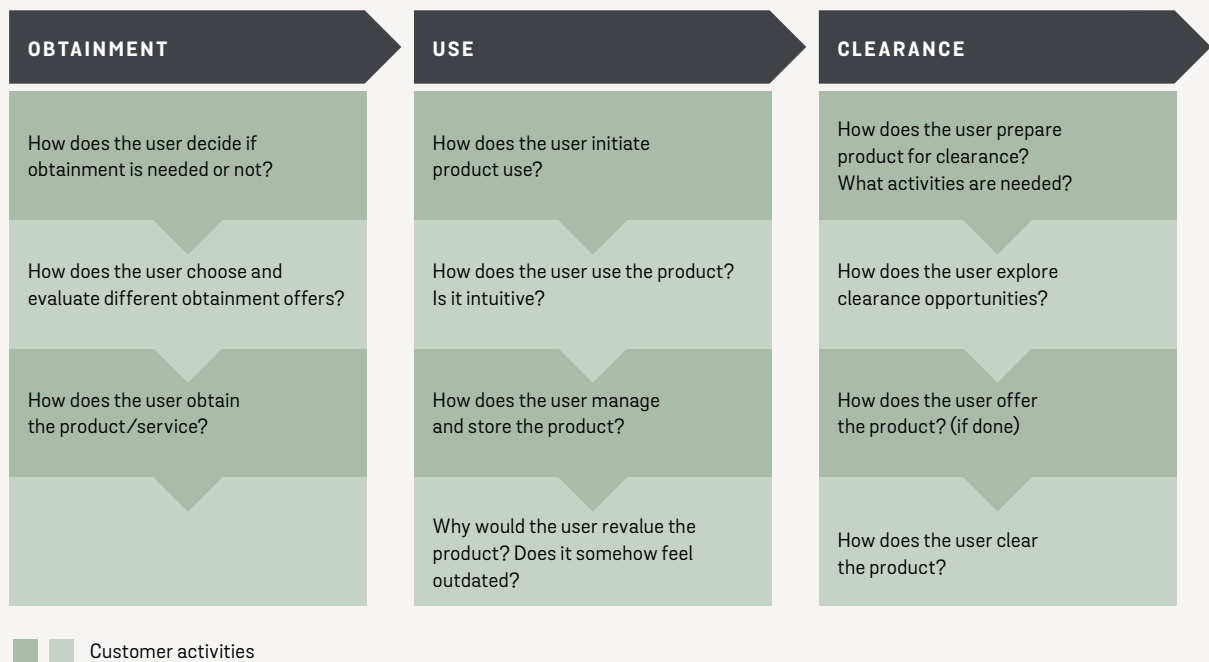
solve the core need identified in step 1. The more you know about the user experience beforehand (by interviews, surveys etc.), the more detailed the mapping can get. The customer journey is divided into three main parts [65]:

1. Obtainment. Activities related to how the user obtains the product.
2. Use. Activities related to how the user uses the product.
3. Clearance. Activities related to how the user clears (ie, sells, discards, gives away) the product at the end of the use cycle.

Once the mapping is completed, categorise the activities according to whether they constitute positive (gains) or negative (pains) experiences. Bring these insights to step 3.

EXHIBIT 11: EXAMPLE OF CUSTOMER JOURNEY MAPPING

Map out the customer's activities in the baseline. This can be your current offer or the dominant market solution.



Step 3: Customer journey mapping: PaaS

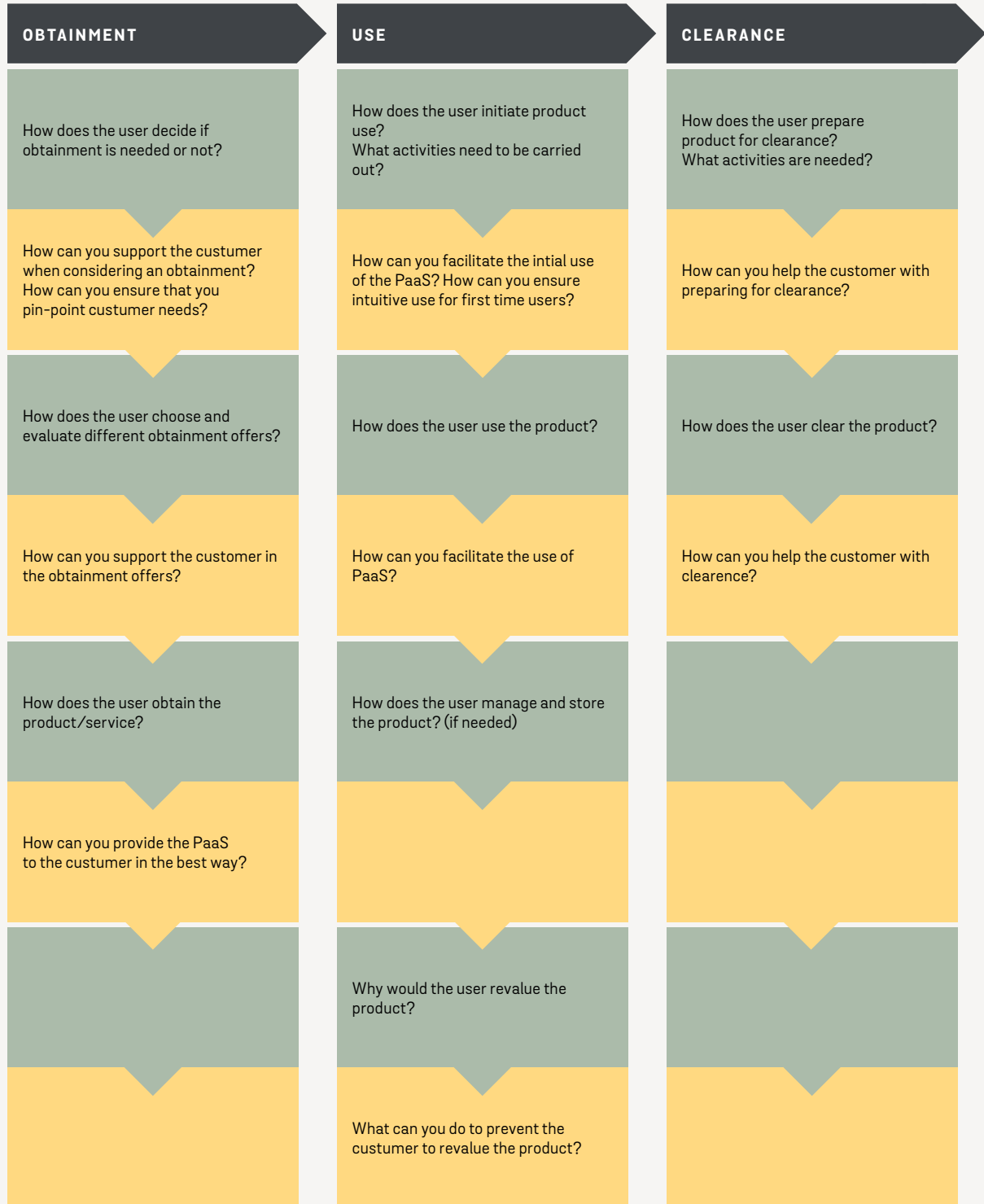
Make a customer journey mapping for your PaaS offering following the same three main phases as in the baseline scenario. Categorise the activities as to whether they constitute positive (gains) or negative (pain) experiences.

Ideate on how your offer can increase customer gains and reduce customer pains. Use the “added value toolbox” to ideate on how your offer can provide financial, functional, emotional, social and strategic value to your customer compared with the baseline scenario.

At this stage, you will also map out the organisational activities needed to support the customer's actions.

EXHIBIT 12: EXAMPLE OF CUSTOMER JOURNEY MAPPING

Map out your Product-as-a-Service customer journey. Think about how you can support your customer throughout the journey and improve their experience compared with the baseline scenario.



- Customer activities
- Organisational activities

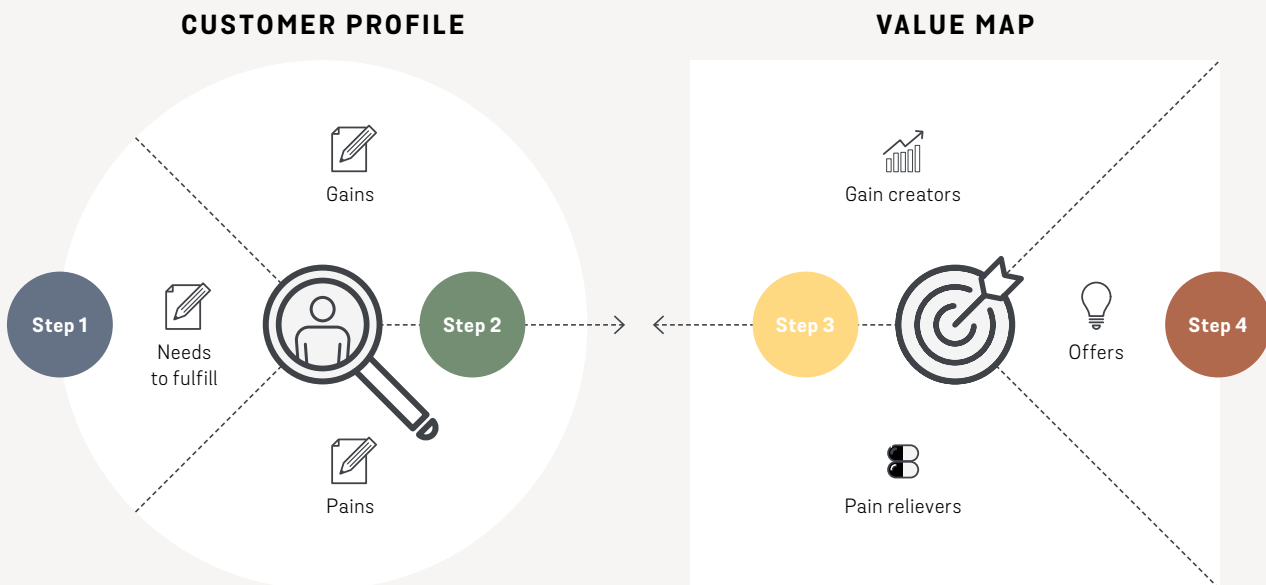
Step 4: Value proposition canvas

Summarise your findings from each step 1-3 in the customer profile and value map which constitute the value proposition canvas. Once this is done, describe your offer in one to three sentences (step 4).

This step provides you with an overview of how your PaaS offer addresses your customer's needs.

EXHIBIT 13: VALUE PROPOSITION CANVAS

Summarise your findings from each step in the value proposition canvas



Step 5: Total cost of ownership calculation for the baseline scenario and the PaaS offering

As cost is a critical determinant of a customer’s consumption choices, it is important to understand what the TCO is for a customer in the baseline scenario. Given that there are many costs the customers aren’t paying for upfront in conventional business models, uncovering the full TCO both helps them understand how much they are really paying currently and what they can expect to pay in your PaaS alternative. This will also help you identify how you can help the customer save money by reducing the TCO (see also [Exhibit 4](#) and [Exhibit 5](#) in Chapter 1). This information will inform price-setting when developing the PaaS

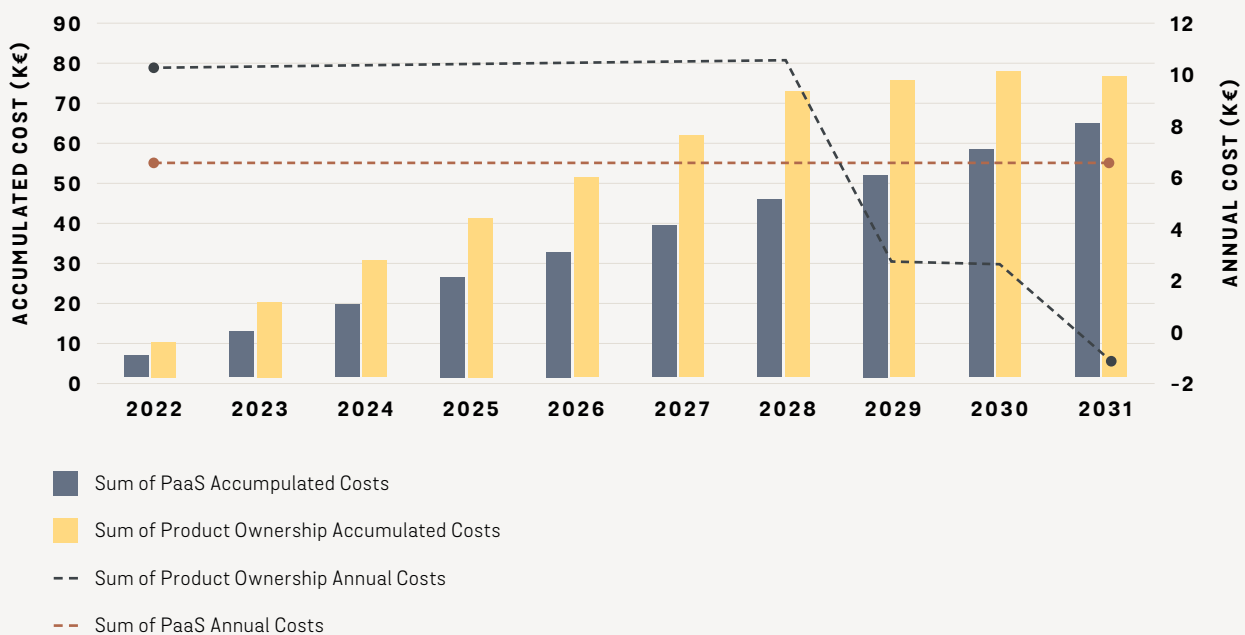
business model (section 3.3.). Some PaaS providers also use this information to present the benefits of the PaaS model compared to traditional renting and educate their existing customers when approached by competitors stating that PaaS is not cost-effective [16].

The TCO calculation can be conducted in the TCO spreadsheet model, where you specify product lifetime, payment options, and the customer’s cost throughout the product’s useful life. This provides you with an overview of the customer’s annual and accumulated costs for product ownership and if applicable, for your PaaS offering (Exhibit 14).

EXPLANATION OF TCO DASHBOARD

The graph shows a TCO calculation comparing PaaS and product ownership for a passenger car over 10 years. The left axis shows the accumulated cost represented by the bars and the right axis shows the annual cost represented by the dotted lines in the chart. The PaaS has a predictable and stable annual cost over the years with little to no variations. Product ownership has more unpredictable and rising costs over time (ie, maintenance and error costs). In this example, the payment period is seven years. Therefore, annual costs increase initially, then drop to a lower level for two years followed by the final year when the car is resold and therefore has a negative annual cost (due to the car’s remaining value). In this example, PaaS has a lower total cost than product ownership, however, product ownership is cheaper during the three final years.

EXHIBIT 14: THE TOTAL COST OF OWNERSHIP DASHBOARD



3.3 BUILD YOUR PRODUCT-AS-A-SERVICE BUSINESS CASE

To mitigate the financial challenges of PaaS, it is important that you assess, iterate, and test the financial viability of your business model. This part of the methodology helps you understand the value potential of your business model, calculate the financial break-even point, and test the feasibility of different pricing strategies.

1. Business case tool

The business case tool is a spreadsheet model helping you do a financial forecast as well as capture performance metrics for your PaaS business model that are key in making decisions to drive the business in the right direction. It is designed to fit pay-per-use models, subscriptions, and hybrids. The tool calculates critical KPIs (Key Performance Indicators) that help you both forecast and follow up on the viability of the business. This tool is designed to be iterated in parallel with the business model ideation phase. This way it's possible to test business case viability comprehensively.

The business case tool section consists of 3 parts: PaaS model inputs, Revenue model forecast and Cost Model forecast. A dashboard that monitors important metrics from the calculations made in these three parts will be presented at the end as an output of the tool.

Part 1: PaaS model inputs

General business model inputs on a product level are given in this section, such as the name of the PaaS offering, the respective product under offer, the type of PaaS offering (leasing, renting, pay-per-use, subscriptions) and the expected number of use cycles. A good overview of your existing and future PaaS business model is helpful so you can provide the required inputs before diving into the financial forecast section.

Part 2: Revenue model forecast

As in any PaaS model, the provider will need to continuously deliver value to the customers as the customers have the flexibility to withdraw from the service whenever they deem it doesn't fit their needs or preferences. Therefore, it is important to allocate a reasonable value when it's time to enter a number of service agreements sold in the first year, annual increment/decrement % in the price of the offering, the predicted % increase in

the new sales (also known as the growth rate) and the predicted % decrease of the withdrawn service agreements annually (also called the churn rate). If the PaaS model is based on 'pay-per-use', the user will also need to input the average use of the product per year in its respective units (tonnes, hours etc.).

With these inputs, forecasts for the following KPIs can be made:

- **Churn Value** This represents the number of customers who chose to withdraw from the service agreement (subscription, pay-per-use). It is critical for a PaaS provider to ensure that the churn value is lower than the new sales made. If it isn't, the business will see decreasing revenues.
- **Annual Recurring Revenue (ARR)** is a business metric which shows the expected recurring revenue annually. It is the annualised version of Monthly Recurring Revenue (MRR). With ARR, the company can see how the revenue compounds each year and is useful to create long term planning and effectively manage your road maps.
- **Preserved Material Value (PMV)** is another metric that is important when assessing a PaaS business model's performance. One crucial advantage that a PaaS provider has is the ownership of the product throughout its lifecycle. The upside of retaining product ownership is that you get access to the potential material value from products that have reached the end of their useful life. This metric helps you visualise the expected value that can be derived from a product through reuse of components or recycling.

Part 3: Cost Model forecast

Cost Structure is split into three sections – Cost of Goods sold (COGs), Operational Expenditures (OPEX) and Investments. This part of the tool includes the most common and relevant cost categories under each section. It also allows for the input of a dynamic cost change (%increase/decrease) for each category for coming years in order to provide as accurate a forecast as possible.

Example: In the case of material costs, there is a possibility to experience a percentage decrease in material costs in future years owing to some material recovery from retired products in the previous year. At the same time, a percentage increase in costs is also possible if the provider decides to add a product feature, perhaps to improve the product's modularity. The modularity may reduce maintenance and upgrading costs in future years, but will likely also demand a higher production cost.

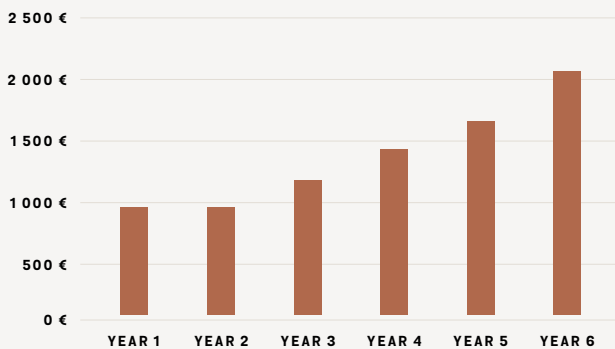
Business Performance Dashboard

The dashboard contains four key metrics which makes it possible to monitor the entire business case year by year.

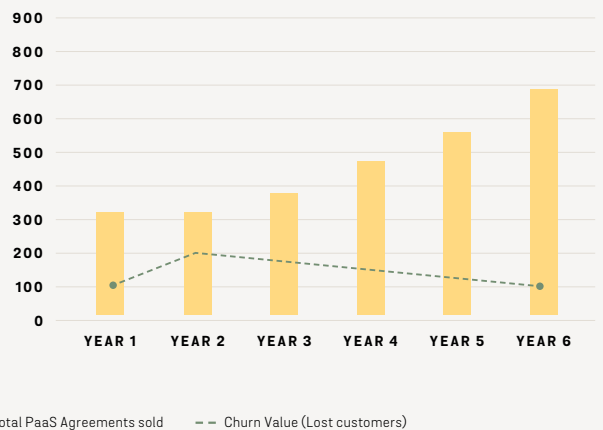
1. Annual Recurring Revenue
2. Churn value over total PaaS agreements sold (gives a sense of the sales performance versus customers opting out of the agreement)
3. Preserved Material Value (shows the material cost savings obtained from recovery of materials)
4. Cost-Benefit Chart (shows where the total costs break even with the operating income)

EXHIBIT 15: EXAMPLE OF THE BUSINESS PERFORMANCE DASHBOARD

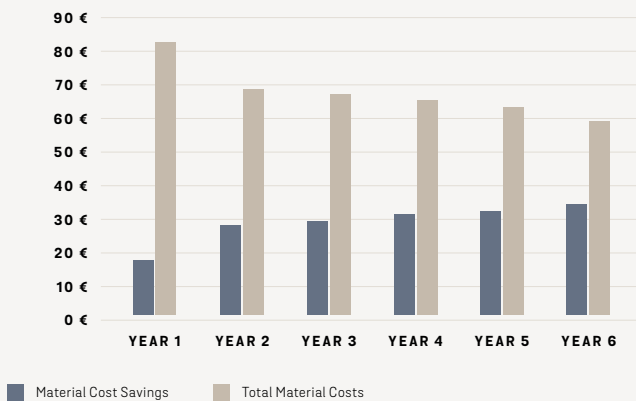
MONTHLY RECURRING REVENUE



CHURN VALUE OVER TOTAL PaaS AGREEMENTS SOLD



PRESERVED MATERIAL VALUE



COST-BENEFIT ANALYSIS



2. Pricing model

The choice of a pricing model is one of your key decisions since it will impact the sustainability performance, product utilisation rate, customer convenience, as well as revenue and operational cost. The two main types of pricing models, pay-per-use and pay-per-period (ie, subscription), come with different advantages and limitations. The optimal pricing model depends on the physical product involved, the provider's cost structure and the customer segment and characteristics [66].

From an environmental impact perspective, a pay-per-use model can perform better than a subscription model as customers become more conscious about use patterns, mainly due to the ticking-meter effect which reduces the use intensity per customer. The ticking-meter effect refers to the discomfort that customers feel when each extra usage unit (eg, minute of use) costs money. This would allow more users to be served by one product, thereby reducing the number of products needed and increasing resource efficiency. Accordingly, subscription policies could lead to unconscious overconsumption and thus increased environmental impact (through otherwise avoidable wear on the product, unnecessary energy consumption etc.) since in this case, high utilisation does not introduce an extra cost. Subscription models often link one product to one user, therefore being less resource-efficient than pay-per-use models [67].

A subscription model may not be beneficial for providers with high operational costs unless combined with an additional pay-per-use fee. For example, a provider of a Laundry-as-a-Service can secure a stable monthly revenue with a subscription model. Simultaneously, they can regulate the utilisation rate of the washing machines – and thus reduce the operational costs as less energy is needed – with an additional pay-per-use fee. For providers with high product utilisation rates, which don't critically affect the operational cost, the pay-

per-use model may be preferred, as it generates higher revenues per product [67].

On the other hand, the subscription model is in many cases the more convenient option for the user. For example, it is likely a more feasible pricing model for products used frequently (or continuously) by the same user (consider a refrigerator or a laptop). The same may be true where it's difficult or inconvenient to measure the frequency of use (consider a pair of jeans). In addition, the subscription model provides the benefit of a more predictable cash flow. Thus, it is preferred by some investors [12] and may be chosen to both increase the potential to receive external capital or loans, as well as to reduce the exposure to financial risk.

How to decide? Consider the following [68]:

- Which pricing model makes more sense from a customer point of view? It is crucial to be able to explain to your customers why your pricing model is convenient – and cost-efficient – for them. Talk to your customers or your would-be customers about your product and how you want to charge for it and consider this information in your decision making.
- Test two different pricing models and see which one is more successful.
- Consider what model moves you closer to creating a sustainable business. Subscription models may look like the reasonable answer but sometimes, the nature of the product may make it challenging to retain long-term subscription customers, making pay-per-use a better choice.
- Experiment with price setting, eg, down payments, different subscription periods, member fees etc.

A summary of advantages and limitations is found in Table 5. Together with the business case calculation tool, this information will help you select the most suitable pricing model.

TABLE 5: ADVANTAGES AND LIMITATIONS WITH PAY-PER-USE AND SUBSCRIPTION PRICING POLICIES

	PAY-PER-USE	SUBSCRIPTION
Description	Customers pay each time the product is used (sometimes combined with a flat rate per period; hybrid).	Customers pay a recurring fee for a particular period (eg, per month) independent of usage level (sometimes combined with an usage intensity fee; hybrid).
Advantages	<ul style="list-style-type: none"> + Small entry barrier, ie, customers can easily use the service, without commitments to monthly plans etc [66]. + Better cost-per-use: allows for better tracking of what sells and what doesn't and redirects the provider's focus [68]. + Enhances inventory management: allows the provider to retain inventory that is in line with current customer demand, avoiding overstocking or out-of-stock cases [66]. + Often environmentally superior to subscription. [67]. 	<ul style="list-style-type: none"> + High customer retention due to a stronger provider-customer relationship and it being harder to leave: the hassle of switching to a new service or cancelling the subscription can be a barrier for customers considering leaving [69]. + Better fit for service quality improvement due to a stronger provider-customer relationship [66]. + High revenue predictability and recurrence [70]; low fluctuations on revenues [66].
Limitations	<ul style="list-style-type: none"> - Low customer retention: does not establish provider-customer relationship; easier entry for competitors [66]. - Hard to predict revenue and resources needed for operations: depends on use intensity [66]. - No recurring fixed revenue [70]. 	<ul style="list-style-type: none"> - Susceptible to changes in customers' interest [66]. - Must continuously provide value to customers: providers need to maintain a high engagement with the customers and devote continuous effort (time, capital etc.) to improve service quality [66].

3.4 IDENTIFY YOUR CORE ASSETS

A PaaS business model requires strategic asset management to avoid the negative effects of being asset-heavy. This part of the method combines a capability assessment tool developed for a business striving to be asset-light, with a capability assessment tool developed for companies in PaaS-transition. One way of gaining a good overview of your assets is to review your company's key capabilities by assessing their strategic importance and ease of implementation. By doing so, you can determine which capabilities are core and should be kept in-house, and which capabilities provide you with little added-value, or even risk making you asset-heavy.

Furthermore, for start-ups with limited capital as well as for more established organisations, launching a PaaS business model is likely to require new capabilities. At the same time, developing all the necessary capabilities internally is rarely a sustainable strategic decision as it risks requiring significant investments

and assets. As pointed out in section 2.3, asset-light companies typically outperform their asset-heavy peers, hence it is important to reflect on where your core capabilities lie and where it is more efficient to outsource activities to partners.

In this part of the methodology, you will conduct a strategic capability assessment. The capability assessment allows you to map out and prioritise both the traditional and PaaS-specific capabilities necessary to execute your business model based on their strategic importance and ease of implementation. This will help you decide which capabilities to develop or keep internal, which to build through partnerships, and which to outsource.

This exercise is supported by a capability assessment tool building on previous work by Ernst & Young [55] and Nordic Innovation [71] but has been further tailored to fit PaaS business models.

Step 1: Assess your capabilities' ease of implementation and strategic importance

The first step requires you to assess your capabilities. The tool highlights twelve capabilities in the areas of Design & Innovation, Sales & Marketing, Operations, Structure & Strategy and Purchasing & Logistics. You are welcome to use these capabilities in your assessment. If you would like to further customise your capabilities, a suggestion is to draw on the capabilities and skills you identified in step 3 of "Design for added customer value" (section 3.2.).

Step 2: View the capability prioritisation map and suggested actions

The last step of the capability assessment includes going through the result on the map and reviewing the suggested actions related to the location of the capabilities on the prioritisation map. The map identifies capabilities as core or non-core. Core-capabilities are either strategic or high-priority. Non-core capabilities are either low-priority or strategic.

A1: Strategic capabilities

These capabilities have high strategic importance but are difficult to implement.

Because of their high strategic value, it is important that you can easily access and steer these capabilities. However, due to their difficulty to implement (either because of the low maturity within the organisation or to challenges in the external system) it might be costly to maintain or develop these capabilities in-house. A suggested way forward is to keep and/or develop these capabilities in close partnership with external experts.

A2: High priority capabilities

These capabilities have high strategic importance and are easy to implement.

Because of their high strategic value and the profitable position your company has regarding the implementation of these capabilities, they should remain close to your organisation, preferably in-house. If your company does not have easy access to these capabilities, the next step could be to develop a plan for how to internalise them.

A3: Low-priority capabilities

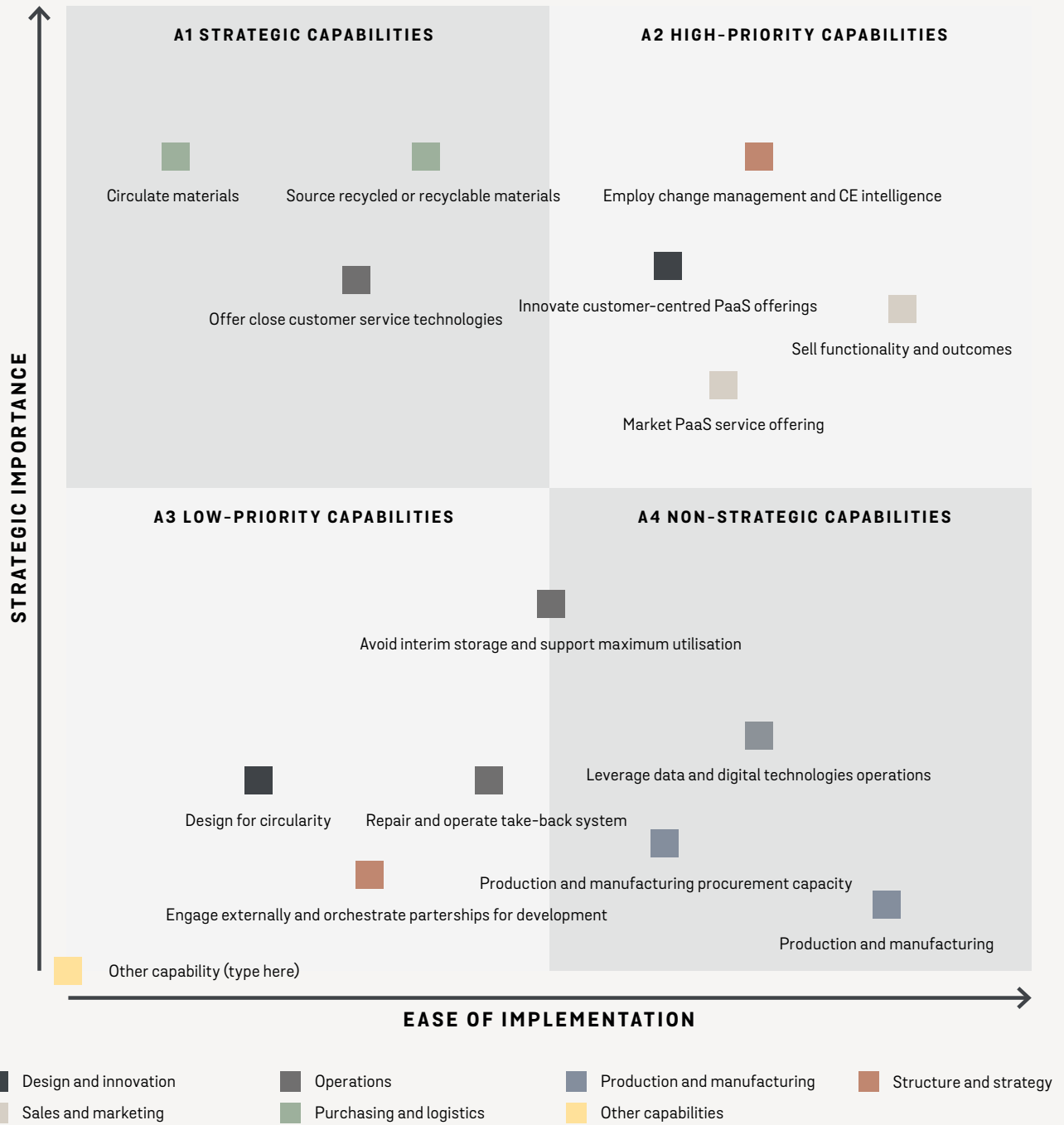
These capabilities have low strategic importance and are difficult to implement. Due to this, they might not currently (or in a near future) create any additional value to your organisation. Maybe these capabilities have been of low priority for a while, or they have been rendered obsolete in a recent organisational change? Suggested action for these capabilities is either to outsource if profitable, or to consider monetising them.

A4: Non-strategic capabilities

These capabilities have low strategic importance but are easy to implement.

They are currently non-core, as they have a low strategic importance both for customers and your company. On the other side, they are not difficult to implement for your organisation. As such, two different actions are possible for these capabilities. If the capabilities are showing to be very far from your current and future strategic ambitions, you might consider outsourcing them if cost-efficient. Or, if you anticipate the capabilities to gain a stronger strategic importance in the future, you might want to keep them close and invest in their strategic development.

EXHIBIT 16: CAPABILITY MATRIX



4. CREATING THE CONDITIONS FOR PRODUCT-AS-A-SERVICE TO THRIVE

Although the most important enablers of PaaS – the digital infrastructure and the increasing demand for sustainable solutions – are already here, the slow uptake of PaaS in practice shows the need to create a better environment for these types of business models. To reduce the cost disadvantage of PaaS compared with linear product-sales business models, policymakers need to shape policies that promote resource efficiency. To build stronger demand, public agencies need to use functional requirements and circular economy metrics in procurement processes to a much greater extent than at present. Finally, to reduce the financial risk of PaaS, financial institutions need to adapt existing financial tools and products, and build internal competencies. This will support these new and important, but still unconventional, business models.

PaaS business models represent an opportunity to align the economic agenda of businesses with the circular economy. This report presents the challenges SMEs face when trying to capitalise on this opportunity, as well as business-level actions to improve the probability of success for developing and launching a PaaS model. While some challenges can be mitigated by businesses themselves, it is clear both market and regulatory failures have created an institutional and financial environment unable to promote this transition on a broader level. To accelerate the circular economy transition, we urge representatives from policy, the public sector, and financial institutions to take the actions needed to create a more supportive environment for businesses looking to adopt a PaaS business model.

4.1 THREE ENABLERS TO LEVEL THE PLAYING FIELD, BOOST DEMAND AND LOWER FINANCIAL RISK

A decade of reports, academic and white papers has left a large body of recommendations to businesses, policymakers, and civil society on how to enable and advance the circular economy. Many of the most frequently discussed enablers are applicable to PaaS but will not be revisited extensively here. Instead, three broad enablers are outlined, directed to three groups of stakeholders who can each play a vital role in scaling PaaS business models: policymakers (responsible for shaping the economic playing field through legislation), public institutions (driving ~15% of

national GDP through public procurement) and financial institutions (supporting PaaS providers through loans and other vehicles). The enablers are described at a rather high level, but each description includes references for further reading.

1. Shape policy instruments to incentivise function over resource use

PaaS business models are often labour-intensive due to higher levels of customer interactions, reverse logistics, repair/remanufacturing etc. They therefore face a cost disadvantage compared to linear product-sales business models that have designed out costly labour in favour of energy and raw materials, which are cheaper (and lower taxed) input factors. Policymakers need to consider the potential of implementing different policy instruments to favour resource-efficient business and consumption practices. Examples include shifting the tax burden from labour to virgin finite resources [9] [72] and implementing fiscal incentives that support training and hiring of expertise relevant to circular business models (eg, remanufacturing or refurbishing) [72].

Moving tax from labour to virgin finite resources is by no means a new idea, but it is nevertheless an important one for policymakers to consider seriously in light of the mounting evidence that current incentives structures are not moving businesses fast enough towards low-carbon and circular economy practices. Perhaps the time for a larger tax code overhaul has come.

The most obvious resource to tax directly would be fossil carbon; a one-off tax on virgin fossil resources entering the marketplace would directly impact all practices favouring fossil-derived energy and materials without hitting recirculated (or renewable) resources, while not being prescriptive about what alternative solutions are desirable. But it is reasonable to assume PaaS business models would benefit as they drive higher product utilisation, durability and recirculation at the expense of high-volume sales and waste generation.

Another piece in the policy toolbox is the extended producer responsibility (EPR) scheme, in which the manufacturer of a product has to pay for all or some of its EoL treatment costs. Historically, EPR schemes have mainly been designed to fund waste management without much consideration to best options for material recirculation. However, there is ongoing work in the EU exploring how to extend the scope of EPR schemes, eg, with modulated fees based on which EoL pathway a material takes [73] [74]. In addition, suggestions exist to go even further, and design 'Producer Ownership schemes' to replace EPR, which would mandate some extent of product ownership by the producer through its lifecycle [13].

2. Favour PaaS in public procurement

Public sector organisations and agencies can directly stimulate the development of PaaS business models. In the EU, over 250 000 public agencies spend approximately 14% of GDP on purchases of supplies, products, services, and works (around €2 trillion per year). About 55% of these procurement procedures still use lowest price as their main criteria for awarding public contracts [75]. Buying equipment at lowest possible cost risks leading to large service costs later on and/or having to replace equipment sooner than necessary (along with associated transaction costs). Integrating circular economy metrics and using functional requirements in procurement has a high potential to stimulate the growth of alternative business models [76] [9].

Although several national initiatives to promote circular public procurement [77] [78] exist, significant development of public organisations' procurement processes is still needed if public procurement is to contribute to improved circularity and reduced environmental impact [79]. Done well, however, it could be a significant market-making mechanism, as well as saving public (ie, taxpayer) money.

3. Redefine how value and risk is assessed by financial institutions

To promote the transition to the circular economy, financial institutions (eg, banks and large asset managers) need to adapt existing financial tools and products (eg, loans) to support unconventional business models [80]. This is especially true in the context of PaaS. Businesses operating a PaaS business model are likely to be assessed as high-risk when using traditional financial ratios, due to having a larger balance sheet and distributed revenue streams. At the same time, SMEs' access to capital is vital to accelerate the establishment of PaaS in practice, as the development of a PaaS offer is associated with high upfront investments.

It is therefore important that financial institutions and investors:

- Ensure adequate competencies internally to support PaaS providers to manage large balance sheets and develop new financing solutions that grant providers access to credit that fits their financial needs [80].
- Develop innovative evaluation methods to assess the financial viability of PaaS business models. Evaluation models may need to consider other thresholds for key measures such as solvability [57] in addition to properly accounting for long-term revenue potential and reduced exposure to linear risks. The latter may include exposure to both monetary risks, such as fluctuating resource prices, or physical risks such as pollution and environmental damage [72].

4.2 THE MOST IMPORTANT ENABLERS ARE ALREADY HERE

Although this report might convey a picture that PaaS business models are likely to struggle within the current market and regulatory contexts, the fact is that the conditions for PaaS to succeed have never been better (still challenging, but never better). Crucially, during the last decade PaaS has been discussed as a key component of a circular economy transition and three of the most important enablers have emerged and matured.

First, the necessary digital infrastructure to manage complex networks of servitised products has developed exponentially, to a point where most products can be equipped with monitoring equipment and processes made more efficient using technologies such as artificial intelligence (AI) and the internet of things (IoT). Such an infrastructure is essential to enable monitoring, transactions, seamless user swaps, predictive maintenance, efficient reverse-logistics and more. In more advanced industries (eg, automotive) it is already becoming a standard. In other words, the digital tools needed to manage PaaS at scale, even for traditionally more challenging customer segments such as private consumers, are already a reality.

Moreover, the supportive ecosystem of PaaS is slowly maturing, with actors offering novel insurance, funding, IT, and logistic solutions fit for sharing or pooling products between users.

Second, awareness of the need to shift to a more circular economy has never been greater and is also growing among the arguably most conservative group of customers: consumers. Despite our urge to own and personalise things, a number of cultural as well as economic factors are changing consumer preferences in large parts of the world. For example, 67% of global consumers tried to have a positive impact on the environment through their everyday actions in 2021 [81], and in 2022, 65 % of a sample of consumers in Sweden, Norway, Finland, Denmark and Poland stated that they would like to adapt their consumption to a low-carbon lifestyle [3]. At the same time, the growth

of platform-based business models [82] means that consumers are increasingly used to alternative ways of fulfilling needs that go beyond product ownership.

Third, the potential customer base amongst companies and public organisations is also growing. In fact, 85.1% of companies in Europe now state that climate action is extremely or very important for their business [83], more than 70 countries have set a net-zero target, and over 1000 cities have pledged to take immediate action to halve global emissions by 2030 [84]. This means that both the public and private sector is in stark need of solutions that reduce the environmental impact of their consumption and operations.

With these three crucial enabling conditions in mind, and equipped with an awareness of the nine critical challenges to PaaS and how to fix them, one can argue that we are now more able than ever to put products-as-a-service in the service of the circular economy. The time for PaaS is now.

REFERENCES

- [1] W. R. Stahel, *The Performance Economy*, Second Edition, London: Palgrave MacMillan, 2010.
- [2] Ellen MacArthur Foundation, "Towards a circular economy: Business rationale for an accelerated transition," Ellen MacArthur Foundation, 2015.
- [3] Stena Recycling, "The Circular Voice," 2022.
- [4] Systemiq, "Everything-as-a-service XaaS: How businesses can thrive in the age of climate change and digitalization," Systemiq, 2022.
- [5] L. L. Kjaer, A. Pagoropoulos, J. H. Schmidt and T. C. McAlloone, "Challenges when evaluating Product/Service-Systems through Life Cycle Assessment," *Journal of Cleaner Production*, vol. 120, pp. 95-104, 2016.
- [6] D. C. Pigosso and T. C. McAlloone, "Maturity-based approach for the development of environmentally sustainable product/service-systems," *CIRP Journal of Manufacturing Science and Technology*, vol. 15, pp. 33-41, 2016.
- [7] A. P. Barquet, J. Seidel, T. Buchert, M. Galeitzke, S. Neugebauer, N. Oertwig, H. Rozenfeld and G. Seliger, "Sustainable Product Service Systems – From Concept Creation to the Detailing of a Business Model for a Bicycle Sharing System in Berlin," *Procedia CIRP*, vol. 40, pp. 524-529, 2016.
- [8] L. Kjær, D. C. A. Pigosso, M. Niero, T. C. McAlloone and N. M. Bech, "Product/Service Systems for a Circular Economy: The Route to Decoupling Economic Growth from Resource Consumption?," *Journal of Industrial Ecology*, 2018.
- [9] Circle Economy, "The Circularity Gap Report - Sweden," 2022.
- [10] Ellen MacArthur Foundation, "Circular economy introduction," Ellen MacArthur Foundation, [Online]. Available: <https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview#:~:text=A%20circular%20economy%20decouples%20economic,loss%2C%20waste%2C%20and%20pollution..> [Accessed 05 07 2022].
- [11] Eurostat, "Circular material use rate," Eurostat, 25 11 2021. [Online]. Available: https://ec.europa.eu/eurostat/databrowser/view/sdg_12_41/default/table?lang=en. [Accessed 10 05 2022].
- [12] N. M. P. Bocken, E. A. Olivetti, J. M. Cullen, J. Potting and R. Lifset, "Taking the Circularity to the Next Level: A Special Issue on the Circular Economy," *Journal of Industrial Ecology*, vol. 21, no. 3, pp. 476-482, 2017.
- [13] Systemiq; UCL Institute for Sustainable Resources, "Making Materials Work for Life - Introducing Producer Ownership," 2019.
- [14] A. Rondini, J. Matschewsky, P. G and G. Bertoni, "A simplified approach towards customer and provider value in PSS for small and medium-sized enterprises," 10th CIRP Conference on Industrial Product-Service Systems, IPS2 2018, 29-31 May 2018,, vol. 73, pp. 61-66, 2019.
- [15] D. A. de Jesus Pacheco, C. Schwengber ten Caten, C. F. Jung, C. Sassanelli and S. Terzie, "Overcoming barriers towards Sustainable Product-Service Systems in Small and Medium-sized enterprises: State of the art and a novel Decision Matrix," *Journal of Cleaner Production*, vol. 222, pp. 903-921, 2019.
- [16] S. B. Moore and S. L. Manring, "Strategy development in small and medium sized enterprises for sustainability and increased value creation," *Journal of Cleaner Production*, vol. 17, no. 2, pp. 276-282, 2009.
- [17] European Commission, "User guide to the SME Definition," 2016. [Online]. Available: https://ec.europa.eu/growth/smes/sme-definition_en.
- [18] Danish Technological Institute; Planet, "SMEs and the environment in the European Union," Publications Office of the European Union, 2014.

- [19] European Environment Agency, "Reducing loss of resources from waste management is key to strengthening the circular economy in Europe," 06 04 2021. [Online]. Available: <https://www.eea.europa.eu/publications/reducing-loss-of-resources-from>. [Accessed 23 08 2022].
- [20] European Environmental Bureau, "Most EU member states miss collection target for electronic waste, NGOs demand quick action from European Commission," 2022.
- [21] Eurostat, "Waste statistics - electrical and electronic equipment," 2022.
- [22] OECD, "Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD," 2022.
- [23] M. J. Goedkoop, C. J. van Halen, H. R. te Riele and P. J. Rommens, "Product Service systems, Ecological and Economic Basics," Ministry of Environment, The Hague, Netherlands, 1999.
- [24] A. Tukker, "Eight types of product-service system: Eight ways to sustainability? Experiences from SusProNet," *Business Strategy and the Environment*, vol. 13, p. 246-260, 2004.
- [25] D. Borg, O. Mont and H. Schoonover, "Consumer Acceptance and Value in Use-Oriented Product-Service Systems: Lessons from Swedish Consumer Goods Companies," *Sustainability*, vol. 12, no. 19, p. 8079, 2020.
- [26] T. Baines, H. Lightfoot, S. Evans, A. Neely, R. Greenough, J. Peppard, R. Roy, E. Shehab, A. Braganza, A. Tiwari, J. Alcock, J. Angus, M. Bastl, A. Cousens, P. Irving, M. Johnson, J. Kingston, H. Lockett, V. Martinez, P. Michele, D. Tranfield, I. Walton and H. Wilson, "State-of-the-art in product-service systems," *Journal of Engineering Manufacture*, vol. 221, no. 10, pp. 1543-1552, 2007.
- [27] F. H. Beuren, M. G. G. Ferreira and P. A. C. Miguel, "Product-service systems: a literature review on integrated products and services," *Journal of Cleaner Production*, vol. 47, pp. 222-231, 2013.
- [28] O. Mont, "Drivers and barriers for shifting towards more service-oriented businesses: Analysis of the PSS field and contributions from Sweden," *The Journal of Sustainable Product Design*, vol. 2, pp. 89-103, 2002.
- [29] T. Valvisto, "Customer value of circular product-service systems," LUT School of Business and Management, Lappeenranta, 2021.
- [30] P. Wang, X. Ming, D. Li, F. Kong, L. Wang and Z. Wu, "Status review and research strategies on product-service systems," *International Journal of Production Research*, vol. 49, no. 22, pp. 6863-6883, 2011.
- [31] G. Michellini, R. N. Moraes, R. N. Cunha, J. M. H. Costa and A. R. Omettoa, "From linear to circular economy: PSS conducting the transition," *Procedia CIRP*, vol. 64, pp. 2-6, 2017.
- [32] M. Kamal, S. Uthayasankar, A. Bigdeli, F. Missi and Y. Koliouis, "Servitization implementation in the manufacturing organizations: classification of strategies, definitions, benefits and challenges," *International Journal of Information Management*, vol. 55, no. 6, 2020.
- [33] Emerald Group Publishing, "What is servitization of manufacturing? A quick introduction," 01 28 2020. [Online]. Available: <https://www.emeraldgrouppublishing.com/opinion-and-blog/what-servitization-manufacturing-a-quick-introduction>.
- [34] Rolls-Royce, "Rolls-Royce celebrates 50th anniversary of Power-by-the-Hour," 30 10 2012. [Online]. Available: <https://www.rolls-royce.com/media/press-releases-archive/yr-2012/121030-the-hour.aspx>. [Accessed 10 05 2022].
- [35] P. Koudal, *The Service Revolution in Global Manufacturing Industries*, Deloitte, 2006.
- [36] R. Wise and P. Baumgartner, "Go Downstream: The New Profit Imperative in Manufacturing," *Harvard Business Review*, Vols. September-October, pp. 133-141, 1999.
- [37] S. Johnstone, A. Dainty and A. Wilkinson, "Integrating products and services through life: An Aerospace experience," *International Journal of Operations and Production Management*, vol. 29, no. 5, pp. 520-538, 2009.

- [38] Rolls-Royce, "Power by the hour," Rolls-Royce, 2017. [Online]. Available: <https://www.rolls-royce.com/media/our-stories/discover/2017/totalcare.aspx>. [Accessed 01 06 2022].
- [39] The Advanced Services Group, "Servitization case study: Caterpillar & its dealerships".
- [40] Cat Rental Store, "Boost productivity with long-term rentals," 2022. [Online]. Available: https://www.catrentalstore.com/en_US/blog/long-term-rental-benefits.html. [Accessed 01 06 2022].
- [41] R. H. W. Boyer, A. Mellquist, M. Williander, S. Fallahi, T. Nyström, M. Linder, P. Algurén, Vanacore, E, A. Hunka, Rex, E and K. Whalen, "Three-dimensional product circularity," *Journal of Industrial Ecology*, vol. 25, no. 4, pp. 1-10, 2021.
- [42] C. Vezzoli, F. Ceschin, L. Osanjo, R. Mugendi, R. Moalosi, V. Nakazibwe and J. Diehl, "Sustainable Product-Service System (S.PSS)," in *Designing Sustainable Energy for All*, Cham, Springer, 2018, pp. 41-51.
- [43] P. Akbar and S. Hoffmann, "Under which circumstances do consumers choose a product service system (PSS)? Consumer benefits and costs of sharing in PSS," *Journal of Cleaner Production*, vol. 201, pp. 416-427, 2018.
- [44] D. Vermunt, S. Negro, P. Verweij, D. Kuppens and M. Hekkert, "Exploring barriers to implementing different circular business models," *Journal of Cleaner Production*, vol. 222, pp. 891-902, 2019.
- [45] A. Cantú, E. Aguiñaga and C. Scheel, "Learning from Failure and Success: The Challenges for Circular Economy Implementation in SMEs in an Emerging Economy," *Sustainability*, vol. 13, no. 3, p. 1529, 2021.
- [46] M. Andor, A. Gerster, K. Gillingham and M. Horvath, "Running a car costs much more than people think - stalling the uptake of green travel," *Nature*, vol. 580, no. 7804, p. 453-455, 2020.
- [47] M. Brunnhofer, N. Gabriella, J.-P. Schöggel, T. Stern and A. Posch, "The biorefinery transition in the European pulp and paper industry – A three-phase Delphi study including a SWOT-AHP analysis," *Forest Policy and Economics*, vol. 110, 2020.
- [48] M. Catulli, M. Cook and S. Potter, "What value do consumers really expect from Product Service Systems? Reflections on how a different conception of value could facilitate the implementation of PSS in consumer markets," in *Paper presented at Sustainable Innovation 2014 - 19th Int Conf, Copenhagen, Denmark, 2014*.
- [49] S. Moro, C.-M. P.A and G. Mendes, "Product-service systems benefits and barriers: an overview of literature review papers," *International Journal of Industrial Engineering and Management*, vol. 11, no. 1, pp. 61-70, 2020.
- [50] O. Mont, A. Plepys, K. Whalen and J. L. Nußholz, "Business model innovation for a circular economy: Drivers and barriers for the Swedish industry – the voice of REES companies," 2017. [Online]. Available: https://lucris.lub.lu.se/ws/portalfiles/portal/33914256/MISTRA_REES_Drivers_and_Barriers_Lund.pdf.
- [51] P. van Loon and L. van Wassenhove, "Transition to the circular economy: the story of four case companies," *International Journal of Production Research*, vol. 58, no. 11, pp. 3415-3422, 2020.
- [52] S. Gupta, H. Chen, B. T. Hazen, S. Kaurd and E. D. S. Gonzaleze, "Circular economy and big data analytics: A stakeholder perspective," *Technological Forecasting and Social Change*, vol. 144, pp. 466-474, 2019.
- [53] W. Reinartz and W. Ulaga, "How to sell services more profitably," *Harvard Business Review*, vol. 86, no. 5, 2008.
- [54] MASD, "Business Model: Asset Heavy Vs Asset Light," 2021. [Online]. Available: <https://taxguru.in/finance/business-model-asset-heavy-asset-light.html>. [Accessed 2022].
- [55] EY, "Using asset-light business models can fuel growth and strengthen financial results," 26 03 2021. [Online]. Available: https://www.ey.com/en_gl/strategy-transactions/how-asset-light-strategies-and-models-can-boost-business-growth. [Accessed 30 04 2022].
- [56] R. Antikainen, R. Baudry, A. Gössnitzer, T. K. M. Karppinen and M. Kishna, "Circular business models: Product-service systems on the way to a circular economy," *European Network of the Heads of Environment Protection Agencies (EPA Network) - Interest Group on Green and Circular Economy*, 2021.

- [57] Circle Economy, “Product-as-a-Service Question Kit”.
- [58] C. Tardi, “Leaseback,” Investopedia, 25 10 2020. [Online]. Available: <https://www.investopedia.com/terms/l/leaseback.asp>. [Accessed 30 04 2022].
- [59] N. Kachaner and A. Whybrew, “When “Asset Light” Is Right,” BCG, 30 09 2014. [Online]. Available: <https://www.bcg.com/publications/2014/business-model-innovation-growth-asset-light-is-right>. [Accessed 30 04 2022].
- [60] K. Xing and D. Ness, “Transition to product-service systems: principles and business model,” *Procedia CIRP*, vol. 47, pp. 525-530, 2016.
- [61] J. Vinther Talberg and T. Rasmussen, *Product Service Systems – An exploratory study of the barriers to adoption in B2C contexts* (Unpublished master’s thesis), Copenhagen: Copenhagen Business School, 2016.
- [62] S. Rombouts, “Modern Product Characteristics that make for a great Product-as-a-Service offering,” *Firmhouse*, 25 02 2020. [Online]. Available: <https://www.firmhouse.com/blog/product-characteristics-that-make-a-great-product-as-a-service-offering>. [Accessed 01 06 2022].
- [63] S. Rombouts, “8 questions to ask yourself when starting with Product-as-a-Service,” *Firmhouse*, 06 10 2020. [Online]. Available: <https://www.firmhouse.com/blog/8-questions-to-ask-yourself-when-starting-with-product-as-a-service>. [Accessed 01 06 2022].
- [64] S. Rombouts, “The key product characteristics for a good Product-as-a-Service fit,” *Firmhouse*, 19 02 2020. [Online]. Available: <https://www.firmhouse.com/blog/the-key-product-characteristics-for-a-good-product-as-a-service-fit>. [Accessed 01 06 2022].
- [65] O. Rexfelt and A. Selvefors, “The Use2Use Design Toolkit—Tools for User-Centred Circular Design,” *Sustainability*, vol. 10, p. 13, 2021.
- [66] Business Strategy Insights, “Pay As You Go Vs Subscription Business Model: Pros And Cons,” [Online]. Available: <https://www.bstrategyinsights.com/pay-as-you-go-vs-subscription-business-model/>. [Accessed 01 06 2022].
- [67] H. V. Arani, M. Pourakbar, E. van der Laan and R. de Koster, “How to charge in servicizing: Per period or per use?,” *European Journal of Operational Research*, 2022.
- [68] C. Cheng, “18 Top A/B Testing Tools Reviewed by CRO Experts,” 27 09 2019. [Online]. Available: <https://cxl.com/blog/ab-testing-tools/>. [Accessed 22 07 2022].
- [69] A. Altman, “The Pros and Cons of Pay-as-You-Go and Subscription Models,” *Rebilly*, 13 05 2019. [Online]. Available: <https://www.rebilly.com/blog/pay-as-you-go-versus-subscription/>. [Accessed 01 06 2022].
- [70] J. Klemkow and V. Mohs, “A short overview on servitization, as-a-service, subscription and pay-per-x in the industry,” *Adamos*, 03 11 2021. [Online]. Available: <https://www.adamos.com/en/blog/a-short-overview-on-servitization-as-a-service-subscription-and-pay-per-x-in-the-industry/>. [Accessed 01 06 2022].
- [71] Nordic Innovation; The Finnish Innovation Fund Sitra; Accenture , “Nordic Circular Economy Playbook Toolkit: Capability Maturity Assessment,” 2021. [Online]. Available: <https://www.nordicinnovation.org/tools/nordic-circular-economy-playbook-toolkit>. [Accessed 20 06 2022].
- [72] Raes and Jan, “Financing circularity: Demystifying Finance for Circular Economies,” *United Nations Environment Programme*, 2020.
- [73] V. Monier, M. Hestin, J. Cavé, I. Laureysens, E. Watkins, H. Reisinger and L. Porsch, “Development of Guidance on Extended,” *European Commission – DG Environment*, 2014.
- [74] European Commission; Directorate-General for Research and Innovation; De Smet, Michiel ; Linder, Mats ; Koopmans, Rudy ; Doorselaer, Karine van ; Velis, Costas ; De Wilde, Bruno ; Ritschkoff, Anne-Christine; Crippa, Maurizio; Leyssens, Jan, “A circular economy for plastics,” *Publications Office of the European Union, Luxembourg*, 2019.

- [75] European Commission, "Public procurement," 2017. [Online]. Available: https://ec.europa.eu/growth/single-market/public-procurement_en.
- [76] The National Agency for Public Procurement, "Funktionskrav i upphandling," [Online]. Available: <https://www.upphandlingsmyndigheten.se/inkopsprocessen/genomfor-upphandlingen/funktionskrav-i-upphandling/>. [Accessed 05 06 2022].
- [77] The National Agency for Public Procurement, "Upphandling för att främja cirkulär ekonomi," The National Agency for Public Procurement, [Online]. Available: <https://www.upphandlingsmyndigheten.se/om-hallbar-upphandling/miljomassigt-hallbar-upphandling/upphandling-for-att-framja-cirkular-ekonomi/#hallbarhetskriterier>. [Accessed 08 07 2022].
- [78] The Government Offices of Sweden, "The Swedish Government leads the way on climate-smart, circular procurement," The Government Offices of Sweden, 28 02 2022. [Online]. Available: <https://www.government.se/articles/2022/02/the-swedish-government-leads-the-way-on-climate-smart-circular-procurement/>. [Accessed 08 08 2022].
- [79] T. N. A. f. P. Procurement, "De offentliga inköpen behöver bidra till att uppnå de nationella miljö kvalitetsmålen," The National Agency for Public Procurement, [Online]. Available: <https://www.upphandlingsmyndigheten.se/forbered-organisationen/nationella-upphandlingsstrategin/De-offentliga-inkopen-behoover-bidra-till-att-uppna-de-nationella-miljokvalitetsmalen/>. [Accessed 09 08 2022].
- [80] Ellen MacArthur Foundation, "Financing the circular economy: Capturing the opportunity," 2022.
- [81] Euromonitor, "Euromonitor Top 10 Global Consumer Trends 2022, Survey," Euromonitor, 2022.
- [82] W. Ulaga and C. Kowalkowski, "Servitization – A State-of-the-Art Overview and Future Directions," in *The Palgrave Handbook of Service Management*, Palgrave Macmillan., 2022, pp. 169-200.
- [83] Euromonitor, "Euromonitor International Voice of the Industry: sustainability, Survey, fielded in May 2021 and January 2022," 2022.
- [84] United Nations, "For a livable climate: Net-zero commitments must be backed by credible action," [Online]. Available: <https://www.un.org/en/climatechange/net-zero-coalition>. [Accessed 01 07 2022].
- [85] A. Hayes, "Asset Turnover Ratio," Investopedia, 23 02 2022. [Online]. Available: <https://www.investopedia.com/terms/a/assetturnover.asp>. [Accessed 30 04 2022].
- [86] A. Hayes, "Solvency Ratio," Investopedia, 31 August 2021. [Online]. Available: <https://www.investopedia.com/terms/s/solvencyratio.asp>. [Accessed 30 04 2022].
- [87] European Commission, "Life-cycle costing," [Online]. Available: <https://ec.europa.eu/environment/gpp/lcc.htm>. [Accessed 10 05 2022].
- [88] SITRA, "Cases: Compressed air as a service," 28 12 2017. [Online]. Available: <https://www.sitra.fi/en/cases/compressed-air-as-a-service/#:~:text=Tamturbo%20sells%20both%20compressed%20air,indicated%20by%20the%20airflow%20gauge..>
- [89] European Parliament, "Circular economy: definition, importance and benefits," 2015. [Online]. Available: <https://www.europarl.europa.eu/news/en/headlines/economy/20151201ST005603/circular-economy-definition-importance-and-benefits>. [Accessed 2022].
- [90] Ellen MacArthur Foundation; Material Economics, "Completing the picture: How the circular economy tackles climate change," Ellen MacArthur Foundation, 2019.
- [91] K. Gyódi, "Airbnb and hotels during COVID-19: different strategies to survive," *International Journal of Culture, Tourism and Hospitality Research*, 2021.

- [92] Investopedia, "Leaseback," [Online]. Available: [investopedia.com/terms/l/leaseback.asp](https://www.investopedia.com/terms/l/leaseback.asp).
- [93] Munich RE, "Pay-per-part: TRUMPF and Munich Re plan new business model for the manufacturing industry," 14 10 2020. [Online]. Available: <https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2020/2020-10-14-pay-per-part.html#:~:text=The%20TRUMPF%20Group%20and%20Munich,buy%20or%20lease%20any%20equipment..>
- [94] J. Czarnezki and S. van Garsse, "What is Life Cycle Costing?," in *Cost and EU public procurement law: Life-cycle costing for sustainability*, Routledge Press, 2019.
- [95] Euromonitor, "Digital Transformation in Global Manufacturing," Euromonitor International, 2021.
- [96] Euromonitor, "Digital Transformation in Logistics," Euromonitor International, 2022.
- [97] Euromonitor, "Megatrends: Digital Living in the Post-Pandemic Era," Euromonitor International, 2021.
- [98] Circle Economy, "The Circularity Gap Report 2021," Circle Economy, 2021.
- [99] Philips, "Philips - Healthtech leases," [Online]. Available: <https://www.philips.co.uk/healthcare/resources/landing/philips-capital/healthtech-leases>.
- [100] C. Hale, "Fierce Biotech: To Philips, the future means selling more than a better MRI machine," 8 May 2019. [Online]. Available: <https://www.fiercebiotech.com/medtech/to-philips-future-means-selling-more-than-a-better-mri>.
- [101] P. Rosa, C. Sassanelli, A. Urbinati, D. Chiaroni and S. Terzi, "Assessing relations between Circular Economy and Industry 4.0: a systematic literature review," *International Journal of Production Research*, 2019.
- [102] E. a. P. B. Barteková, "Digitalisation for the transition to a resource efficient and circular economy", *OECD Environment Working Papers*, No. 192, OECD Publishing, Paris," 2022.

REFERENCE LIST OF THE INTERVIEWEES

Note number	Description
I1	Joel Smedberg, CEO, Brighteco. Light-aaS.
I2	David Knutsson, Founder, Parently. Children accessories-aaS.
I3	Gustav Hedström, Business Controller & Innovation, Houdini Sportswear AB. Outdoor clothing-aaS.
I4	Magnus Engström, Founder, Envivo. Office furniture-aaS.
I5	Martin Willers, Co-founder & CEO, Transparent Sound. Sound devices-aaS.
I6	Fredrik Karlberg, Founder, Jonna AB. Bicycles-aaS.
I7	Joakim Hilding, Founder, Furnlease. Furniture-aaS.
I8	Johanna Norrman, Former CEO & Co-founder, Its:Released. Clothing-aaS
I9	Sebastian Holmström, Sustainability Manager, Inrego. Electronic devices-aaS.
I10	Yann Toutant, Founder and CEO, Black Winch. The As-A-Service experts.
I11	Viktor Tingström, Co-founder, Lisa&.
I12	Mats Olausson, Senior Advisor, Climate and Sustainability Finance and Jakob Hansson, Structured Asset Finance, SEB.
I13	Team of experts in business development and finance, Almi.
I14	Michiel De Smet, Sustainable Investment Expert, National Bank of Belgium.
I15	Erik Valvring, Innovation Strategist, Science Park Borås/CircularHub.
I16	Thomas Eliasson, Finance Director and Linda Nilsson, Marketing Manager, Elis Textilservice. Textiles-aaS.
I17	Pontus Björkdahl, Head of Sustainability, Svenska Retursystem. Pallets-aaS.
I18	Ove Lidström, Head of Business Development & Innovation, Foxway Group AB. Electronic devices-aaS.
I19	Amanda Cawood, Project manager, Accus. Signs-aaS.

ADDITIONAL RESOURCES

Additional methodologies and tools to help you design and develop a circular business model can be found in the table below.

TITLE	PURPOSE	TARGET GROUP	ORGANISATION/ AUTHORS	LINK
Circular Economy Playbook	Tools to help you build a circular business model and design a transformation journey	All companies	Nordic Innovation	Nordic Circular Economy Playbook Nordic Innovation
Use2Use Design Toolkit	Help you ideate and evaluate circular design concepts from a user-perspective	All companies	Annelie Selvefors, Oskar Røxfeldt	The Use2Use Design Toolkit – USE2USE – circularity from a user perspective
Overcoming the product-service model adoption obstacles	Self-assessment questionnaire for companies interested in adopting PSS	All companies	Marcus Vinicius Pereira Pessôa, Juan Manuel Jauregui Becker	Overcoming the Product-Service Model Adoption Obstacles - ScienceDirect
Circular business model planning tool	Help design business models that extend the useful life of products and materials and capitalise on the associated value	All companies	Julia L.K.NuBholz	CBM_Planning_Tool_Guide_Class.pdf (lu.se)
The Circular Design Guide	Collection of tools to help you understand, define, make, and release circular innovations	All companies	Ellen MacArthur Foundation and IDEO	Methods (circulardesign-guide.com)
Circular business model canvas	Help you explore a circular business model	All companies	Circular Hub	Circular Business Model Canvas - CircularHub
Designing your circular transition	Toolbox to guide you through a circular innovation process	All companies	DDC (Danish Design Center)	DDC – Danish Design Center Designing Your Circular Transition
A simplified approach towards customer and provider value in PSS for SMEs	Methodology to evaluate the PaaS business model at an early design phase, from a provider and customer perspective	SMEs	Alice Rondini, Johannes Matschewsky, Giuditta Pezzotta, Marco Bertoni	Report link

CONTACT

Mats Linder

Head of Consulting,
[Stena Circular Consulting](#)
mats.linder@stenarecycling.se

Elin Bergman

COO & Vice Chair,
[Cradlenet](#)
elin@cradlenet.se

Cradlenet



EUROPEAN
UNION
European Regional
Development Fund

 **STENA**
RECYCLING