Delft University of Technology

Business Models

Product Service Systems

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Customer owns

Product Service System
Ownership varies, value comes from combining product & se

Product Oriented

Use Oriented

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Customer Ownership
Company manufactures, customer buys

Sell

Product Related Service
Sell product with related service (e.g. maintenance contract)

Sell

Service

Product Lease
Exclusive use, but without owning product*

Lease

Outs
Third party
Provi

Sell

Legend

Manufacturer or Provider

Product (Washing Machine)

Value Transaction

Product User

Service Provider

Advice & Consulting
Sell product & advise on use (e.g. training)

Sell

Advice

Product Renting / Sharing
Non-exclusive use;
Renting: provider owns.
Sharing: a customer owns.

Sell/Rent

Pay Per
User pays p

Sell

Product Related Software
Sell software running on product

Sell

Software

10101

Product Pooling
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Software can be its own product, service, or mix.

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Service Unit
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Service System Likely Environmental Benefits:

- Reduce manufacturing material & energy demand
- Reduce use-phase material & energy demand
- Incentivize extended producer responsibility
- Incentivize durable products
- Incentivize product upgrade
- Professionalizing maintenance extends product life
- Efficiency/economy of scale
- Ease collection at end of life

*Note: Leasing sometimes shortens product life due to user carelessness.

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Service

Source: Jeremy Faludi.

Business Models

Product Service Systems

*Jeremy Faludi,
Conny Bakker,
and Ruud Balkenende*

Goals

- Apply Product Service Systems (PSSs) to make circular design strategies economically viable

- Illustrate examples of a pure product, a product service system, and a pure service

- Explain the differences between a pure product, a product service system, and a pure service

- Analyze existing products/services, and ideate new ones, using the Product Service System Landscape

Why It Matters

Business models are great enablers of the circular economy—without a supporting business model, many circular product designs fail in the long run. The business model of selling products to a mass audience often drives premature obsolescence, because long-lived products reduce new product sales. Designing for durability, repair, etc., often increases the initial cost, while purchasers usually prioritize low initial cost over lifetime cost, making long-lived products less popular. Thus, unless governments mandate design for long life, you need to find a way for your company to make money from longer product lifetimes and reduced manufacturing. This might be done with branding, but a deeper system intervention is changing from a business model of selling products to a product service system.

Business models are important for designers and engineers to understand, even if you never run a business, because your product design will not be viable if it clashes with your company's business model. "Aligning the incentives" of economics and sustainability means your company makes more money when your product lasts longer. Your goal doesn't need to be maximizing profit, you could aim for sufficiency, but you need to show economic viability, and a PSS can do that.

Summary

- Product service systems (PSSs) are revenue models where customers pay the company for the service the product provides, not (only) for the physical product itself.
- Designing the revenue model along with the product can align economic incentives with environmental impacts, so the company has an incentive to design products for longer lives.
- Both the company and the customer can benefit financially from longer-lived products billed as services.
- Not all product service systems are sustainable environmentally or socially, but if properly designed, they can greatly enable the circular economy.

21.1 Product Service System Concept

A product service system (PSS) combines some kind of service with a physical product. Not all PSSs are sustainable, but the goal of a sustainable PSS is to align company revenue streams with resource efficiency by providing services that supplement or replace physical product manufacturing. In other words, decoupling company revenue from physical stuff, so that the stuff becomes a cost rather than a revenue stream. The company providing the service does not have to be the same company manufacturing the physical product. For example, most car rental companies are not car manufacturers, and they are the ones capturing the increased revenue, not the manufacturers. To create a sustainable PSS, be careful to align the incentives of profit and circularity.

There are countless different PSS business models—you can be as creative about them as you are in your physical product design. According to Sakao and Lindahl (2009), a successful PSS must address three things: (1) the user (or customer), (2) the offering, and (3) the service provider. This is because PSSs enable the provider and the product manufacturer to be different companies. The "offering" is whatever combination of physical product and service. Software can be a product or can enable a service—it depends on the revenue model. Tukker (2004) was the first to create a taxonomy of different possible variations of user, manufacturer, product, service provider, and offering; this chapter will detail it later for both brainstorming new PSSs and analyzing existing ones.

One of the earliest examples of a PSS is jet engines for aircraft: in the 1990s, Rolls-Royce

went from selling engines to selling "power by the hour" (Figure 21.1). Airline accountants were delighted because it eliminated the large cost spikes of buying a new engine and decommissioning an old engine, turning it into a constant easy-to-budget monthly cost. Rolls-Royce was incentivized to make more durable, maintainable, repairable, and upgradable engines, because materials and manufacturing cost them money, while their revenue stream was constant. And not only did Rolls-Royce make more profit from their longer-lasting engines, but the airlines also saved money, because Rolls-Royce kept some of the savings and passed some of the savings on to its customers (Neely, 2008). Even if customers don't save money as they did here, reducing financial risk is often valuable to them.

Figure 21.1 Rolls-Royce jet engines sold as "power by the hour"

Source: Darren Koch, Wikimedia Commons.

A PSS is often easier to start with business customers like this than private customers, because professional buyers are often more methodical about planning for future costs. PSSs are also more attractive to customers when the product is expensive, as customers would already want to spread out payment. Also, when you're designing a PSS, you can afford to spend much more time and effort designing for one large-volume customer than thousands of small customers. Note that to realize sustainability improvements like design for repair and remanufacturing, if the manufacturer and service provider are different companies, they need to collaborate closely for the right knowledge to inform the design.

Product service systems can be especially good for startups. Some products are easy for competitors to imitate, and larger companies can manufacture with greater economies of scale. A PSS can be harder to copy, because the service may establish a closer and longer-lasting relationship with the customer, even beyond any technical or logistical advantages in your service operations. Because these closer and longer-term relationships can provide better customer feedback, PSSs can enable the company to respond more rapidly and easily to a changing market or changing user needs.

21.2 Kinds of Service Systems

There are many different kinds of PSS business models, with several levels between pure product and pure service. Figure 21.2 shows a taxonomy of PSS, based on Tukker (2004) with some modifications.

On the left of Figure 21.2 is the traditional revenue model, the "pure product." For example, the box shows the manufacturer selling a washing machine to the user. As mentioned above, there could be a circular end of life such as the manufacturer providing a takeback system, but the revenue model does not drive it.

The second column has "product-oriented" revenue models: you still mostly sell a product that the user owns, but you also make money from "product-related services" such as maintenance and repair, or "advice and consulting" such as teaching customers how to use it and what they can do with it. If designed correctly, these can let you bring in recurring revenue when the product lasts longer. For a washing machine, you might sell it plus delivery and installation, a warranty for repair, repair services, or even upgrade. Another service could be software (discussed later).

The third column has "use-oriented" models: the user no longer owns the physical product, they pay for using it. But they do still operate it. This includes some of the sharing economy, like an Interface carpet being leased by a building owner, or a communally owned washing machine in an apartment building, used by one person at a time ("product sharing"), or multiple people doing their laundry together in one machine at the same time ("product pooling"). Use-oriented models are often used for aircraft engines as mentioned above; office printers have used product pooling since the 1990s, including Xerox, Canon, and others. Printer driver software enables print jobs from many people to queue in one shared printer; this concept can apply to other products, too.

The next column has "result-oriented" models: the user not only doesn't own the physical product, but they often don't even operate it. They just pay for the result. For example, in the "functional result" model, you might run a cleaning service with some washing machines, some dry cleaners, and some other devices; people drop off their clothes, you wash them, and they pick them up again. In "outsourcing," you hire a third party contractor to do the washing because it's not your core business. An especially powerful strategy is "pay per service unit," as it often aligns incentives better. For example, since 2014, Signify (formerly Philips Lighting) has sold lighting to some customers, including Schipol Airport, as "pay per lux" (Philips, 2014). That means Signify does not sell them bulbs and fixtures, but pays for all hardware, maintenance, repair, etc.; they bill the customers per lux of light emitted over time. Because of this cost and revenue structure, Signify has an economic incentive to make the lighting energy-efficient with long-lived hardware. It's similar to Rolls-Royce's "power by the hour" billing, or Ricoh photocopier's pay-per-copy service system. These models are often called Product As A Service (PaaS) because the emphasis is no longer on the product.

These business models (and others) can also overlap: the ride share companies Lyft and Uber use "outsourcing" because they don't manufacture the cars and don't provide drivers standard employee jobs. They also use "pay per service unit" because customers pay only for the distance/time driven, not a monthly subscription or other fees. They also use "functional result" because a user could be picked up in any car, from a Mercedes sedan to a Toyota truck. Sometimes they even use "product pooling" when users share part of their ride with others.
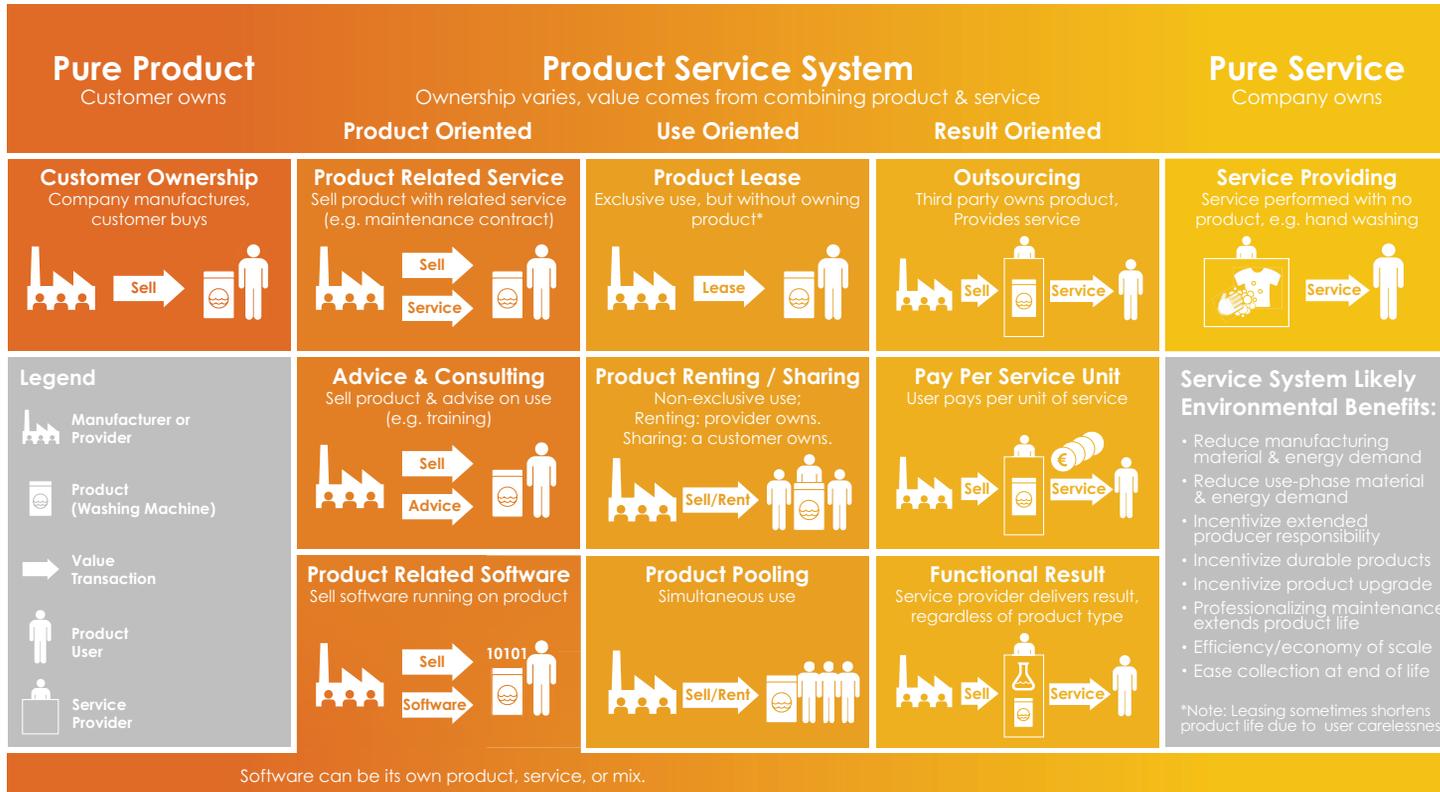
Pure Product
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Product Service System
Ownership varies, value comes from combining product & service

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Company manufactures, customer buys

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Product Related Service
Sell product with related service (e.g. maintenance contract)

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Product Lease
Exclusive use, but without owning product*

Lease

Outsourcing
Third party owns product, Provides service

Sell   Service

Service Providing
Service performed with no product, e.g. hand washing

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Product (Washing Machine)

Value Transaction

Product User

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Advice & Consulting
Sell product & advise on use (e.g. training)

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Product Renting / Sharing
Non-exclusive use; Renting: provider owns. Sharing: a customer owns.

Sell/Rent

Pay Per Service Unit
User pays per unit of service

Sell   Service

Service System Likely Environmental Benefits:

• Reduce manufacturing material & energy demand
• Reduce use-phase material & energy demand
• Incentivize extended producer responsibility
• Incentivize durable products
• Incentivize product upgrade
• Professionalizing maintenance extends product life
• Efficiency/economy of scale
• Ease collection at end of life

*Note: Leasing sometimes shortens product life due to user carelessness.

Product Related Software
Sell software running on product

Sell   10101
Software

Product Pooling
Simultaneous use

Sell/Rent

Functional Result
Service provider delivers result, regardless of product type

Sell   Service

Software can be its own product, service, or mix.

Figure 21.2 Product service system landscape

Source: Adapted from Tukker (2004) and Plan C.

And, finally, Figure 21.2's last column is "pure service." There is no physical product. In the case of washing clothes, this is not 100% literal—even if your business hand washes clothes, you'll still use soap and water—but it's close enough that hand washing is considered pure service. Most "pure service" businesses are like this—they usually need some back-end infrastructure to perform the service, but the user never sees it, and likely would not be able to operate it without training.

Besides these models from Tukker (2004), another business model is selling software running on the physical product. This means selling one piece of hardware that gets used for a long time and making most (or even all) of your money from recurring software sales. For example, videogame consoles like Nintendos are sold at very low margins because most of the money is made from game software sales. This hasn't been applied to washing machines yet (apps that do exist, like starting the washing machine remotely, are free, not a revenue stream). But who knows what the future holds? Be careful with this strategy: products making most of their money from software may become obsolete sooner, not later, if growing software demands outstrip hardware capabilities.

Software can, itself, be a digital product or service in any of these categories. Most web applications are software-as-a-service (SaaS), as well as some desktop software. In addition, software can enable any or all of the different product service systems described above, whether the software runs on the product itself or on a separate platform, whether or not the software itself generates revenue. For example, mobile phone services are a PSS using phone hardware that runs software to make calls and text messages, etc. Many of these apps are free, but keep users paying for the service. By contrast, car share services like Zipcar, GreenWheels, etc. use normal cars with minor modifications; the software where users make reservations and check availability runs on a website or phone app separate from the car. But such software is often critical for such product sharing and pooling services—car sharing can't give thousands of users each thousands of metal keys for thousands of vehicles in thousands of locations, even if they could manage thousands of paper calendars and maps for them. But an online database can easily give millions of people access to millions of vehicles in millions of locations, with the ability to schedule, track, sort, and filter them for a convenient reservation.

21.3 PSS, Circularity, and Sustainability

Circular business models can keep materials and even whole products circulating for long periods of time and/or many users. Maximizing customer use per physical product maximizes resource efficiency. The Value Hill, shown in Chapter 4, illustrates how this resource efficiency also creates financial value. Not all product service systems are circular business models, and not all circular business models are a PSS. A recycling plant is a circular business model, receiving waste and separating it into pure metals to sell to smelters, that is a circular business model that is not a PSS. A car rental agency is not a circular economy business model unless it makes explicit measures to extend its cars' lives, which most do not.

Companies can be circular and sustainable without using a PSS. Companies like Patagonia and Fairphone already make durable, repairable, or otherwise long-lived products with the standard business model of selling new products. They achieve this through brand recognition that, while their products may cost more initially, they will provide more user value over the long term. However, these are a small percentage of the market, both because consumers mostly prioritize low first cost over lifetime cost or other values, and because the business model of selling new products means faster product turnover increases profits. Companies with long-lasting products need very strong brand value with customers, and strong purpose within the company, to succeed.

Not all PSSs are circular, and not all circular businesses are sustainable. The peer-to-peer ride share company Uber provides a non-sustainable PSS. While its service does reduce the number of cars that need to be manufactured by increasing the usage of each car, the primary environmental impact of cars comes not from their manufacture but from burning fuel to drive them. Uber and similar services may cause 83% more driving than people owning their own vehicles (Henao & Marshall, 2019), because they drive "empty" so far to pick up passengers. Uber also isn't considered socially sustainable, because even though its system financially benefits both the company and the customers more than traditional taxi services, it often pays drivers poorly, with no job security.

Sometimes even PSSs designed for sustainability may cause "rebound effects," where they unintentionally cause more resource use rather than less. Uber's

additional kilometers driven is one example of a rebound effect. Another could be mobile phone services where the service contract includes a phone. While this business model could incentivize the phone company to keep phones in service longer, the company might do the reverse by promising its customers they can always have the latest phone by paying for premium service. Rebound effects are especially likely if the products are not designed with the service in mind, or vice-versa. For example, shared products are often abused, due to users not feeling a sense of ownership. Rental cars often have shorter lifetimes because of this, since the cars are designed like any other car, not more repairable or more durable, usually just selected by rental companies for affordability or style. Bicycle share companies, by contrast, usually provide both the service and the bicycles, so they design the bikes far more robustly to enable longer lives with rougher use.

One way to drive sustainability without PSS or circular business models is for government regulations to outlaw or heavily tax short-lived products, using standard metrics for durability and repairability. However, legislation is slow in coming, especially on the global scale, and many sustainability professionals prefer to motivate companies through rewards rather than penalties. Rather than waiting for legislation, companies can motivate themselves by using product service systems to align profits with circularity.

For example, if you design for repair and long life, but make your money by selling new products, the incentives do not align unless you have exceptional brand value built around that specific reputation. You must work against the incentives, as mentioned

above for Patagonia and Fairphone. If, instead, your company leases a product to customers monthly, then replacing the product hurts your profits compared to leaving the same product in place longer. You have an incentive to make the product durable, maintainable, and repairable. Likewise, if your company pays for the repairs, you have an incentive to make the product faster and easier to repair. Both the company and the customer can save money this way, as with Rolls-Royce and airlines.

Finally, another potential PSS benefit is that the continued relationship between customer and company throughout the life of the product can provide better communication, logistics, and trust, which can help facilitate product take-back for repair, remanufacturing, or recycling. The customer relationship can also help the company encourage customer maintenance or product care. This lowers the barriers to reuse, remanufacturing, dedicated recycling, or other end of life improvements.

21.4 PSS Barriers and Caveats

There are barriers to designing product service systems for the circular economy, like inertia and the need for new infrastructure. If you are a product manufacturer trying to go from pure product to a PSS where your company is also the service provider, you need to operate differently from a "normal" product manufacturer. Figure 21.3 shows a landscape of barriers to PSS and how to overcome them, from the European Commission's (2008) report, "Promoting Innovative Business Models with Environmental Benefits."

In Figure 21.3, magenta circles are barriers to any innovation, and green circles are barriers specific to PSS (and some other sustainable design strategies). The gray circles are ways to help address the barriers. For example, lack of trust can be a barrier to adoption of any new product, sustainable or not, because users are unfamiliar with it. You can overcome this in many ways, but the two ways shown here are to offer a guarantee (e.g., if customers aren't satisfied, they can get their money back), or to retain legal responsibility for the product (e.g., if it malfunctions and damages something, people will sue you, not your customer). As Figure 21.3 shows, the barriers to PSS are mostly the barriers to any innovation.

Some barriers are PSS-specific, though. For example, new infrastructure is often needed, such as a car share service's many cars, parking locations, and the software to schedule, locate, and otherwise manage car pick-up and drop-off. Figure 21.3 shows this barrier can be overcome by starting with a smaller market, or building on existing hardware. For example, the company Swapfiets (started by TU Delft students) provides bicycles as a service for a monthly fee, and broken bikes are swapped out for different ones while the original is repaired and then given to a different user. This requires an extensive network of repair centers (infrastructure), so Swapfiets started with a very limited geographic service area and expanded over time.

The gray circles are not the only solutions to these barriers. For example, lack of trust can be overcome by advertising or communication. Strong collaboration between your company and your customers (especially large institutional customers you can build long-term relationships with) can build trust,

Figure 21.3 Barriers to PSS and how to overcome them
Source: EU Commission (2008).

manage risks, create a common vision, overcome inertia, lower transaction costs, find ways to reduce infrastructure needs, build knowledge, and clarify incentives, all at once. See Chapter 26 for more details.

An important caveat, mentioned earlier, is that not all PSSs are sustainable. Uber and AirBnB have especially been criticized, and even outlawed in many cities around the world. Their outsourcing models have generated profits not by greatly increasing physical resource efficiency but by increasing cost efficiency through avoidance of standard employee contracts, hotel taxes, and the like.

21.5 Choosing a PSS Business Model

How do you apply these ideas to choose a business model that supports your material recovery or other sustainability goals? Figure 21.4 shows an overview.

- In Figure 21.4, **tightest circular loops** means considering what drives the most material and value recovery for your product type: durability, upgradability, product sharing, or something else? Different products get thrown away for different reasons.

- **Customer needs and values** means considering what your customers care most about, or what problem you can solve for them—your value proposition. For example, if initial cost is a problem, a "pay per service" model might be best. If the main problem is long-term cost, or convenience, or reliability, other PSS models might be better. And remember you can combine PSS models to meet multiple needs.

- **Community needs and values** means considering what's best for the people and local economies where the company manufactures, sells, and otherwise operates. Do the people there need more jobs? If so, more "service-oriented" models might be best. Or for poor communities that lack material goods, "product pooling" might be beneficial. Engage with the local communities and consider UN Sustainable Development Goals to find what your business can support.

- **Company strengths and values** means considering what best fits the company skills and resources, and how you can generate the most revenue. Do you currently sell to individuals or institutions? Do you already have a recovery strategy, like take-back programs or maintenance contracts? For example, if you're a car manufacturer that already has an extensive financing business, it's easy for you to expand into leasing, rental, and product pooling. Or if you're a software company starting a new laptop business, it's easy for you to make your laptops a platform for your software sales. You can build on your company strengths with a learning trajectory to overcome the barriers you encounter, such as Figure 21.3's barriers and suggested solutions to try out.

Together, these considerations of tight circularity, customer value, community value, and company strengths help you reach all three points of the Triple Bottom Line. In the end, the benefit of a well-designed circular PSS is that it aligns profits with long product life, repair, and recovery of materials for a circular economy. They can apply to many product categories, from jet engines to lighting to clothing to building materials. As mentioned earlier, they're often easier to set up when targeting institutional customers, but

Tightest circular loops

Customer needs & values

Community needs & values

Company strengths & values

Figure 21.4   Considerations when choosing a PSS

individual people use PSSs like Swapfiets, Rent the Runway, and more. So, what's a good business model for your product and company?

Figure 21.5 shows examples of this: washing machines mostly get thrown away when they break, not because fashion is driving everyone to have this season's hippest model. By contrast, clothing mostly gets thrown out because people want a new fresh look, not because the old clothing was broken. For products that are thrown out when they break, your business might use the "product-related service" model to sell maintenance and repair services, or might use "Product Lease" to capture value from a product designed for longer life. For products that are thrown out for obsolescence, you might use a "Functional Result" model, designing your product for upgrade and customizability, then capturing value from mixing and matching the same parts in new ways.
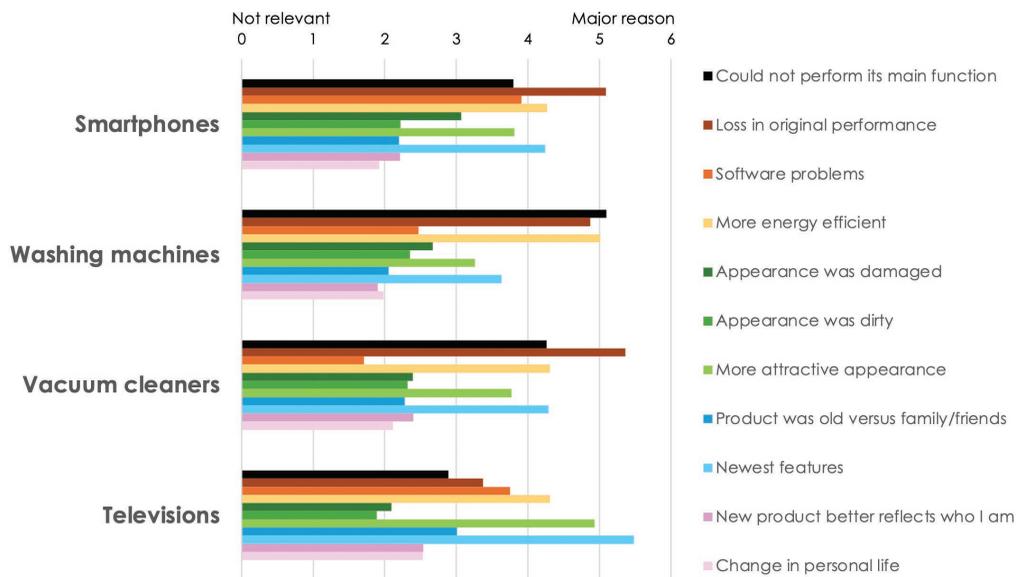

Figure 21.5 Why we throw things away

Source: Magnier & Mugge (2022).

Resources and References

Resources for Further Study

- EU Commission (2008). Promoting innovative business models with environmental benefits. Final Report. COWI. Available at: https://ec.europa.eu/environment/enveco/innovation_technology/pdf/nbm_report.pdf. Especially see Section 5.2, "Business Rationale" (pp. 29–31) and Section 7, "Realizing PSS" (pp. 39–46).

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How to Apply #21: Brainstorm Turning Your Product into a PSS
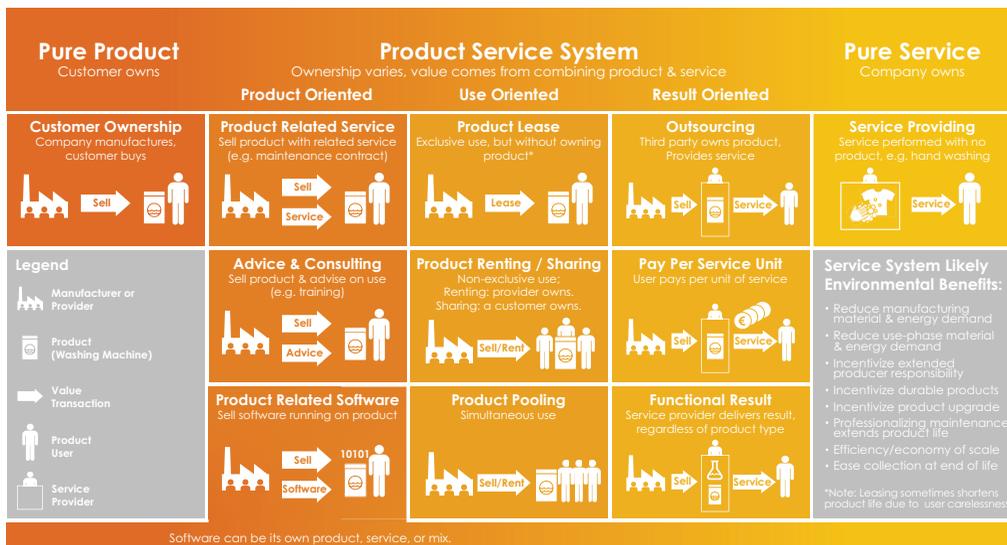### Time Estimate: 1–3 Hours

Goal: Brainstorm product service systems to turn your product into a service for longer lifetime and/or sharing.

STEP 1: Brainstorm Revenue Models to Turn Your Product into a Circular PSS
Time Estimate: 30–60 Minutes

Hold a brainstorm session, based on the PSS landscape (Figure 21.2) and, using the Rules of Brainstorming, to generate ideas for changing the revenue model from a one-time purchase to a service for lifetime and sharing, where your company somehow stays involved in the product's life cycle.

- Ideally have 5–10 ideas for every box in the PSS landscape. (Ideally 60+ total ideas, but a minimum of 30 ideas.) Have more ideas for the boxes more promising for your product/service.

- You don't need to work through your Whole System Map, but you might find it helpful, especially to see how services connect to other parts of the system.

Pure Product Customer owns	Product Service System Ownership varies, value comes from combining product & service			Pure Service Company owns
	Product Oriented	Use Oriented	Result Oriented	
Customer Ownership Company manufactures, customer buys	**Product Related Service** Sell product with related service (e.g. maintenance contract)	**Product Lease** Exclusive use, but without owning product*	**Outsourcing** Third party owns product, Provides service	**Service Providing** Service performed with no product, e.g. hand washing
Legend	**Advice & Consulting** Sell product & advise on use (e.g. training)	**Product Renting / Sharing** Non-exclusive use; Renting: provider owns. Sharing: a customer owns.	**Pay Per Service Unit** User pays per unit of service	**Service System Likely Environmental Benefits:**
Manufacturer or Provider Product (Washing Machine) Value Transaction Product User Service Provider	**Product Related Software** Sell software running on product	**Product Pooling** Simultaneous use	**Functional Result** Service provider delivers result, regardless of product type	• Reduce manufacturing material & energy demand • Reduce use-phase material & energy demand • Incentivize extended producer responsibility • Incentivize durable products • Incentivize product upgrade • Professionalizing maintenance extends product life • Efficiency/economy of scale • Ease collection at end of life *Note: Leasing sometimes shortens product life due to user carelessness
Software can be its own product, service, or mix.				

- For each service idea, list the added value for the customer compared with just purchasing the product. Does it save the user money, either that one time or in the long run? Does it help the user avoid financial or physical or other risk? Does it provide the user more convenience? Something else? Don't write long notes, just a few words like "more convenient" or "lower one-time cost."

- For each service idea, list the added value for you (the manufacturer and/or service provider), compared with just selling the product.

- If desired, you can also mention if there is value added or lost for other parties in the value chain (e.g., component suppliers losing money from fewer new products produced).

STEP 2: Narrow Down Your Brainstorm Options to 3–4 Winning Ideas
Time Estimate: 5–15 Minutes

Use dot voting, decision matrices, or whatever tools you desire, to narrow down your brainstorm to just 3–4 winning candidates. In addition to judging each idea by material reduction per functional unit of service, use considerations from your Design Brief to rule out options that don't meet business criteria, such as cost or usability.

STEP 3: For Each Winning Idea, Sketch and Estimate the Material Reduction of That Option
Time Estimate: 5–30 Minutes

For each of your winning ideas, draw a quick sketch or storyboard of how the customer uses the product and service. Then estimate each idea's percent reduction in material use per functional unit of service compared to the original product. For example, if one idea shares the product between two people but only lasts half as long, it does not save any material per functional unit. Something shared between two people and lasting twice as long would use just 1/4 the material per functional unit, a huge improvement. Show the math for how you got the estimated percent reduction for each idea.

STEP 4: Choose One Winning Idea and Illustrate It
Time Estimate: 20–40 Minutes

Choose one winning idea (or combination of ideas), based on the results of the percent reduction in materials intensity, and your other Design Brief priorities. Create a high-quality image of the winning idea, either by hand or digitally, to clearly convey how the idea is different from the current product, and why it's a compelling design.

STEP 5: Document Your Decision and Brainstorm
Time Estimate: 30–60 Minutes

Create a PDF with the winning redesign (or the top few) and the reasons why it's the best option.

Checklist for Self-Assessment

To score your success on this exercise, see if you…

☐ *Listed all the new ideas.*

☐ *Listed each new idea's value to the customer.*

☐ *Listed each new idea's value to you.*

☐ *Listed (or show labeled sketches of) your top 3–4 ideas.*

☐ *Listed the percent reduction in material use for each of these designs and show the math.*

☐ *Showed the illustration of the winning design.*

☐ *Succinctly described the winning design, either as annotations to the illustration or as a stand-alone sentence or two.*

☐ *Briefly described a convincing business case for the final design choice.*