Generalized conclusions from PaaS sustainability assessment

Product-as-a-Service (PaaS) is a promising business model for many companies. It allows manufacturers to retain ownership of the products they provide to customers, which can increase value for both the company and its customers [1]. By staying involved in the product's lifecycle, manufacturers can offer better service, maintain quality, and build stronger customer relationships. However, businesses need to evaluate whether PaaS suits their needs before they commit. PaaS also affects customers, offering them new ways to access products. Recently, Euroconsumers, co-ordinating the actions of several national consumer organizations at a European level, held a webinar titled, "Renting consumer products as a service: costly gimmick or green dream?" [2]. This event highlighted PaaS as an increasingly popular option for consumers. This article will share key insights on PaaS and its impact on sustainability, based on research from the Scandere project. It will focus on home appliances, like washing machines, vacuum cleaners, and robotic lawn mowers, as well as products for professional use, covering environmental, economic, and social effects to give a well-rounded view of PaaS in practice.

Economic aspect

The main economic factors influencing Product-as-a-Service (PaaS) include the subscription fee (the source of the provider's revenue), contract duration, logistics, services (like maintenance and repair / refurbish), production, and administrative operations. The PaaS fee can be tailored to the perceived value for subscribers, often including hassle-free use and ongoing support length is also key, as a subscriber's total payments typically depend on the fee (per time or usage) multiplied by the duration or usage volume [3]. A basic example under Swedish market conditions, shown in Figure 1 (left side), illustrates the provider's cost structure: in PaaS, service expenses (green) dominate, whereas production costs (grey) are the primary cost in one-time sales.

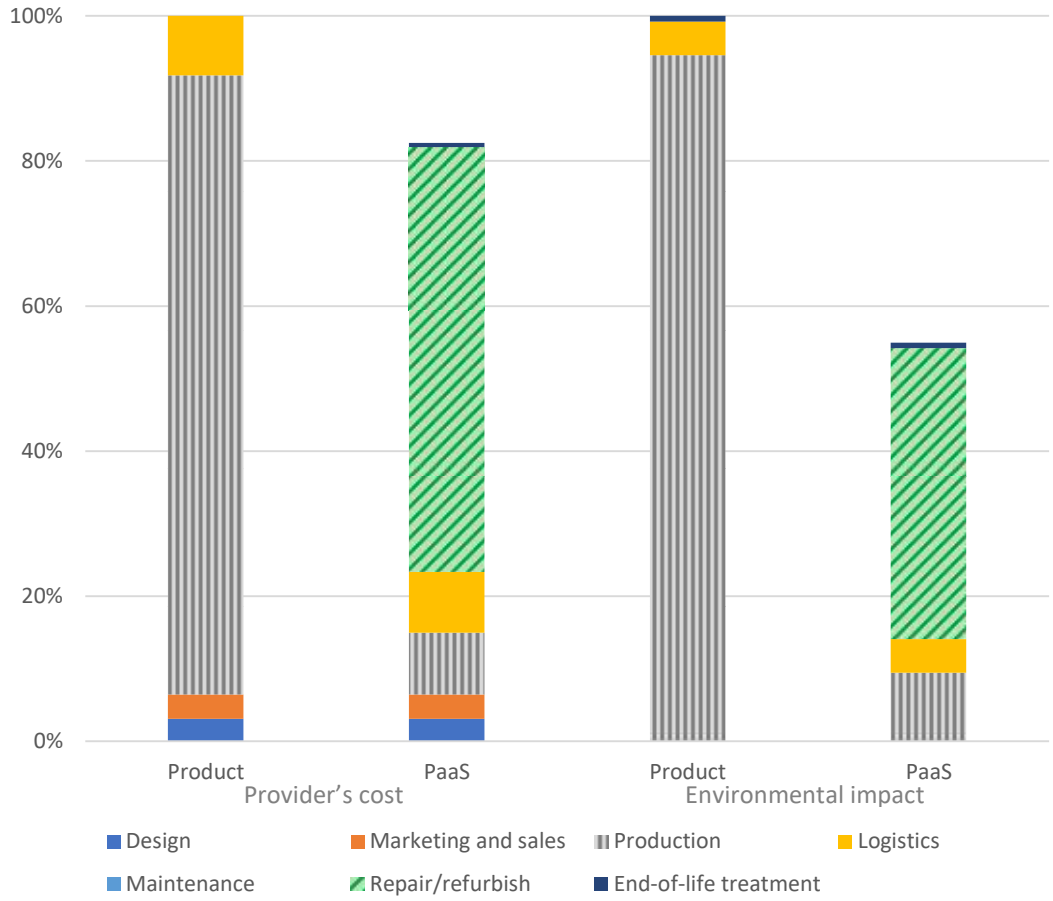

Figure 1. Comparison between the one-off sales of a product (set to be 100%) and the PaaS in provider's cost and environmental impact (global warming potential); modified from [4]

For a PaaS provider, two critical areas to focus on are service offerings and back-office operations [5]. In PaaS, services such as maintenance are especially impactful—particularly in sectors like construction machinery for

professional users, where remote maintenance significantly enhances efficiency [5]. This is why IoT (Internet of Things) can be a powerful enabler for PaaS. It should be remembered that even when a product is owned by the end user, maintenance is necessary though costs are then borne by the user. For private users (like home vacuum cleaners), maintenance costs may not be as critical as they are for professional users. Back-office operations are also essential, as PaaS requires additional support functions that may or may not overlap with one-off sales activities if the provider is an original equipment manufacturer (OEM) operating on a smaller scale. The “double burden” effect of managing the two models is a challenge for PaaS providers. In some cases, as with robotic lawn mowers, employing a third party like a retailer can help reduce back-office costs; however, this approach may reduce direct user contact and limit knowledge-accumulation opportunities [6].
With those said, it depends on a specific case at hand whether a PaaS offering is economically preferred (also environmentally) [10]. Generalization is too hard; however, Figure 2 visualizes key recommendations for PaaS providers. Success in PaaS is not automatically guaranteed and depends on the provider’s ability to manage factors like pricing strategy, long-term product quality, and efficient back-office operations.

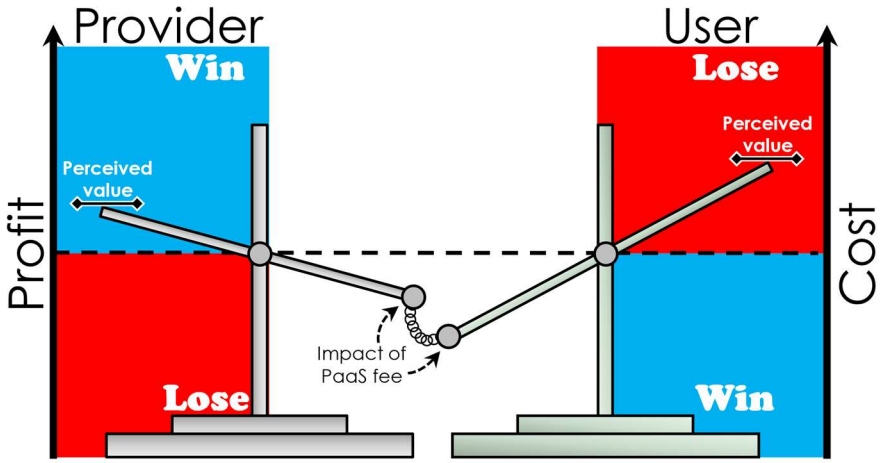

Figure 2. The libra of PaaS from the economic aspect (Source: SCANDERE project).

Environmental aspect

Many studies have highlighted the positive environmental impact of PaaS from a lifecycle perspective [7]. Figure 1 (right side) illustrates an example of its effects on climate change. Like the economic analysis, services (green) play a major role in PaaS, whereas production costs (grey) dominate one-off sales. However, the environmental benefits of PaaS tend to be even greater, mainly because service activities like repair and refurbishment have a bigger impact on reducing climate impact than on reducing economic costs. Services often rely more on human labour than on natural resources, which is why they can contribute positively to sustainability. However, logistics in PaaS can sometimes reduce these environmental benefits, so careful planning is essential to prevent transportation from outweighing service-related savings. In terms of materials use, especially for critical raw materials (CRMs), PaaS models have been found to be environmentally superior, as seen with battery-powered vacuum cleaners [8]. Key factors include product and component lifespan, reuse rates, collection rates, and methods for component recovery. Understanding which of these factors has bigger impacts is critical to minimizing the risk that PaaS could become less sustainable than traditional one-off sales. Further research is underway to clarify this.

Social aspect

The social impact of PaaS is more challenging to assess than its economic and environmental effects, as it covers a wider range of factors. Studies report both benefits and drawbacks [8]: potential positives include local job creation, improved living conditions for users, and adherence to safety standards, while possible downsides involve concerns over consumer privacy and increased working hours for providers. One compelling example is the "Papillon" PaaS offering by BSH for home appliances like washing machines and vacuum cleaners in Belgium since 2018. This program targets families living in poverty who are unable to purchase energy-efficient appliances [9]. BSH partnered with Samenlevingsopbouw West-Vlaanderen, a social enterprise supporting vulnerable communities, to offer energy-efficient appliances on affordable monthly rental terms, as shown in Figure 3. The 10-year rental contract costs around €9 per device per month, with subsidies from the Flemish Minister of the Environment lowering the cost to €7 for end users. The package includes delivery, installation, instruction,

removal of old devices, comprehensive service for the contract term, and device collection at the end of the period. This PaaS model stands out for its innovative value network, providing not only environmental and economic benefits but also substantial social value.

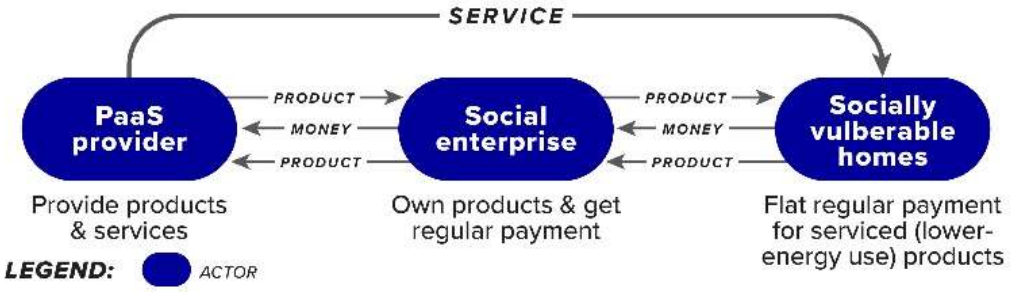

Figure 3 Relations between the three actors in Papillon [10].

The social dimension of PaaS has been far less studied than its environmental and economic aspects, highlighting the need for further research in this area. The above-mentioned webinar [2] may share some interesting perspectives to consider.

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