Report (D5.2)

Decision-making framework including guideline to enhance remanufacturing in PaaS (for journal paper)

for the SCANDERE (Scaling up a circular economy business model by a new design, leaner remanufacturing, and automated material recycling technologies) project

October 2023

Deliverable 5.2 from the SCANDERE project

Grant number 101003575 — ERA-MIN3

Acknowledgement

This project is supported by the ERA-MIN3 program under grant number 101003575. Linköping University (LiU) is financially supported by VINNOVA, Sweden's Innovation Agency (No. 2022-00070). Poznan University of Technology and Elektrorecykling S.A. are financially supported by NCBR, National Centre for Research and Development, Poland (No. ERA-MIN3/1/SCANDERE/4/2022). Université Grenoble Alpes is financially supported by the French ADEME (Ecologic Transition Agency) under contract number 2202D0103. KU Leuven is financially supported by Fonds Wetenschappelijk Onderzoek (FWO) – Vlaanderen / Research Foundation – Flanders (project G0G6121N). Compliance and Risks is financially supported by Geological Survey Ireland (2021-ERAMIN3-001).

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1. Introduction

The Circular economy (CE) concept has transformed business models of companies in the last decade, shifting from the traditional approach "take-make-use-dispose" towards proactive actions towards slowing and closing materials loops in their supply chains. Circular Economy is "restorative and re-generative by design and aims to keep products, components, and materials at their highest utility and value at all times" (Ellen McArthur, 2015, p.2).

In March 2020 the New Circular Economy action Plan (CEAP) has been adopted (COM/2020/98 final), which prioritizes products with high circularity potential, like for example electronics, ICT and textiles. The focus is placed on improving product durability, reusability, upgradability and reparability. Furthermore, actions shall be taken to enable remanufacturing and high-quality recycling and upscaling product-as-a-service (PaaS) or similar models, where producers keep the ownership of the product or the responsibility for its performance throughout its lifecycle (COM/2020/98 final, p. 5).

CE is aimed at implementing a closed supply chain where products, components, and materials are reused repeatedly (Genovese and Nasir, 2017). The economic benefits of the CE concept primarly related to input reduction, efficiency gains, and waste avoidance (Geissdoerfer, 2017). The adoption of the CE concept at a company level affects increased stakeholders (producers and consumers) responsibility and awareness, with regard to "the use of renewable technologies and materials (wherever possible), as well as the adoption of suitable, clear and stable policies and tools" (Ghisellini et al., 2016, p.11).

Companies, as the singular actors own most resources and capabilities, thus they can stimulate CE transition by creating added value through an extended and more proactively managed stakeholders' network (Geissdoerfer, Bocken, and Hultink, 2016). The technological and organizational innovations can lead to the redesign of products and services for reuse and easier value recovery in multiple life-cycles, resulting in new relations between stakeholders in the supply chain (Golinska-Dawson, 2020).

Circular business models (CBM) connect companies' resources and capacities to slow, narrow, and close resource loops (Bocken at al. 2016). Further studies on the CBM recommend companies to intensify the usage phase of the existing resources, and to substitute (where possible) of products selling by service and software solutions (so called dematerializing). The CBM aims to create monetary and non-monetary value by innovations (technological, organizational and social) and pro-active management.

The aim of this document is to develop a decision-making framework (DF) including a guideline to support the scaling up of remanufacturing in PaaS settings especially on the consumer markets (Business to Customer B2C). The DF includes a resource perspective (work force skills and technologies) and a process perspective (efficient material flow for higher material recovery rate). The DF might offer operational, tactical and strategic,

guidelines for practitioners to progress to TRL6. The DF is designed for environmentally and economically viable remanufacturing in PaaS with electrical and electronic equipment (EEE) for B2C.

1.1. Circularity and servitization in the Electrical and Electronic Equipment (EEE) sector

Servitization influences companies' business models, as it involves moving from selling physical products to generating revenue streams through offering access to the usage of product or its performance, or functions (Adrodegari et al., 2017). The concept of product service systems is relatively well established in the literature. PSS is defined here as '*mix of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling final customer needs*' (Tukker & Tischner, 2006). The servitization approaches can be classified as (Tukker, 2015a):

- product-oriented;
- use oriented (e.g., product renting, sharing, and pooling) intensify the use of the products;
- result oriented.

In the case of electrical and electronic products for the consumer markets, pilot projects are run to explore PaaS options with remanufacturing (Bressanelli et al., 2020).

The business model shall (Golinska-Dawson, 2020):

- to provide the value for stakeholders by delivering products and or services;
- to create coopertion both on downstream and upstream in the supply chain;
- to capture value and sustain the financial viability and environmental sustainability;
- to maintain financial stability.

In practice, the servitization in the EEE sector is immature. The majority of OEMs generate relatively low turnover share through services, mainly originating from traditional product-related services, such as spare parts, technical assistance and maintenance (Adrodegari et al., 2017).

Figure 1.1 presents the generic PaaS model with enforced circularity due to the value retention processes.

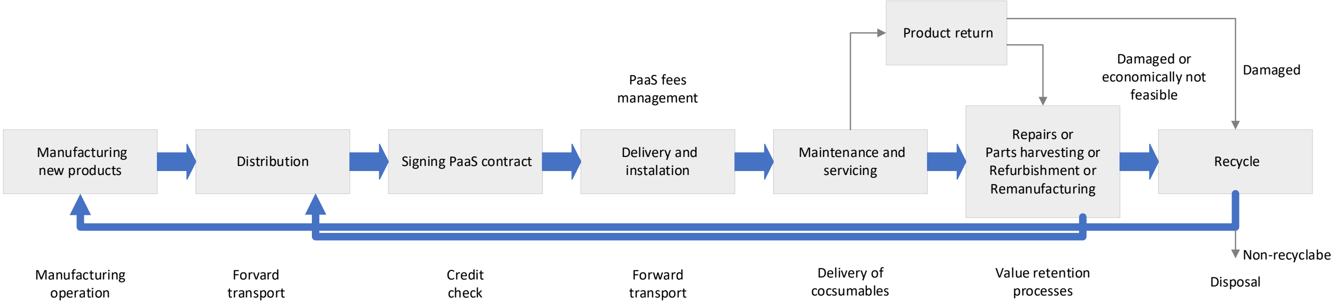

Figure 1. Example of PaaS with circularity

In the EEE sector[1], the circularity is supported by legislative document: Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast from WEEE Directive 2002/96/EC); and Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of Eco-design requirements for energy-related products (recast). The Eco-design Directive[2] imposed regulations on the energy efficiency and specific circularity features of electrical and electronic equipment (EEE). Furthermore, the voluntary EU Ecolabel[3] scheme supports product circularity and energy efficiency, which will be extended in the coming years with systematic criteria on durability, recyclability and recycled content[4].

Electrical and electronic equipment is one of the fastest growing waste streams in the EU. In 2019, 12 Mt of WEEE was generated in the EU (approximately 16.2 kg per person) compared to 11.6 Mt (15.6 kg/person) in 2014[5]. The increasing volume of the disposal of fully or partially functional products because they could not be repaired, batteries could not be replaced, software could not be supported, or materials contained in devices could not be recovered. From the perspective of Circular Economy, the questions have risen about the possibilities of urban mining (Ottoni et al., 2020) and the increased application of various reuse scenarios for the electronical and electric equipment (EEE).

The shift from traditional selling (linear business models) to offering a PaaS for a product (circular business models) changes the economic and organizational conditions for companies. In the traditional selling model, the manufacturing and distribution costs are covered directly by the selling price. The revenue stream is further extended by the repair fees from customers after the end of the warranty period. In the circular business models, the economic benefits can be obtained over multiple life cycles of the product and resource-efficiency, but the revenues and costs stream are differently distributed over the extended and multiple life cycles of the products.

The CE approach in the EEE sector is shown in Figure 2.

[1] NACE: C26 — Manufacture of computer, electronic and optical products, and C27 — Manufacture of electrical equipment
[2] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, OJ L 285, 31.10.2009, p. 10.
[3] Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel, OJ L 27, 30.1.2010, p. 1.
[4] CEAP, p. 6
[5] https://environment.ec.europa.eu/news/improved-weee-data-give-better-picture-collection-and-recycling-rates-2022-12-07_en accessed on 15th March 2023)

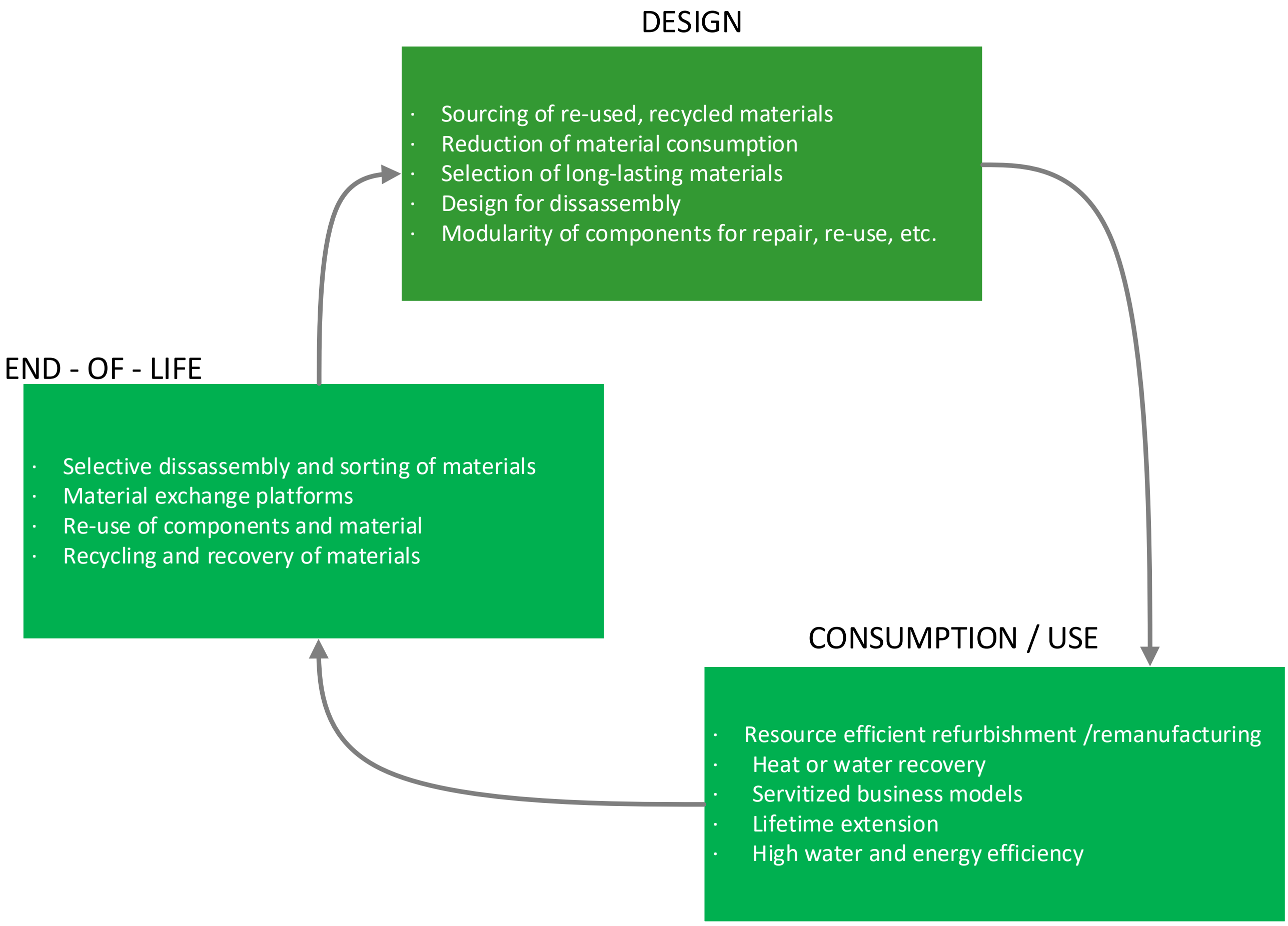

Figure 2. Circularity in EEE

1.2. Value Retention Processes in the Electrical and Electronic Equipment (EEE)

Electrical and electronic equipment (EEE) sector implements various practices to move from wasteful linear business models to cascading and resource efficient solutions along EEE supply chain. Value-retention processes (VRPs), allows to extend the expected service life, and to activate full potential of recapturing resource value (materials, structural form, work load, energy and functions) embedded in products beyond the recycling of materials (Russel and Nasr, 2020).The value retention processes are crucial part of cascading the materials flows in Circular Economy, and they are the entry point for further recycling of products, which are not feasible any more for VRPs.

The value-retention services can be obtained by (IRP, 2018):

- Full-Service Life Processes – which aim for providing a completely new life for every usage cycle of the product and they are performed in the industrial settings;
- Partial Service Life Processes – which aim for the completion of, and/or slight extension of, the expected product service life.

The most popular value retention processes in the EEE sector include:

- Direct reuse (Partial Service-Life VRPs),
- Repair (Partial Service-Life VRPs)
- Refurbishment (Full-Service Life VRPs)
- Remanufacturing (Full-Service Life VRPs)

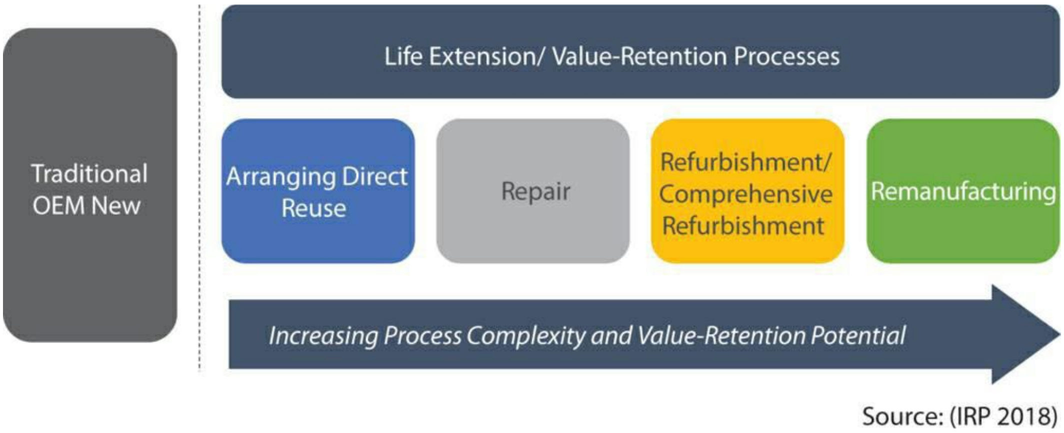

Figure 3. Definitions and structure of value-retention processes (Source : IRP 2018)

The definition and characteristics of the Value Retention Processes are provided in Table 1.

Table 1. Definition of Value Retention Processes (VRPs)

Name of VRP	Processes	Reason for End of Use (EoU)	End of useful service life	Output of VRP
Direct reuse (Partial Service-Life VRPs)	Collection, inspection and testing, cleaning, and redistribution to new users. No disassembly, removal of parts, or addition of parts	User requires an upgraded product, or no longer need the product, or change preferences	Prematurely, as not yet fulfilled its expected life	The product is functional but not guaranteed to meet original specifications.
Repair (Partial Service-Life VRPs)	Collection, inspection and testing, cleaning, some worn or damaged parts removed, and new parts added, redistribution (mainly to the original user)	Failure of defective component	Constrained to complete its original expected life if not repaired	After fixing of a specified malfunction, fully functional product for the duration of its expected life.
Refurbishment (Full-Service Life VRPs)	Collection, inspection and testing, cleaning, data wiping, software	Need to increase or restore performance or	To significantly extend the	Fully functional or upgraded product for the duration

	upgrades, repairs, aesthetics touch-ups, redistribution to the original or s new user	functionality or to meet technical standards or regulatory requirements	expected service life	of almost full new service life
Remanufacturing (Full-Service Life VRPs)	Collection, inspection, complete disassembly at the component-level or module-level of product in the industry settings, cleaning, testing replacing or recovering modules or components, upgrades, reassembly, final quality testing, redistribution to the original or s new user	Need to increase or restore performance or functionality for next service life cycle	To duplicate the expected service life	As good-as-new or better-than-new functionally for the duration of new service life with warranty

Refurbishment- "*the modification of an object that is waste or a product to increase or restore its performance and/or functionality or to meet applicable technical standards or regulatory requirements, with the result of making a fully functional product to be used for a purpose that is at least the one that was originally intended*."[6]

Remanufacturing – "*an industrial process whereby products, referred to as cores, are restored to useful life. During this process, the core passes through a number of operations, e.g., inspection, disassembly, part reprocessing, reassembly, and testing, to ensure it meets the desired product standards*" (Östlin et al., 2008).

The remanufacturing process is case-dependent and industry-dependent. Remanufacturing can be carried out by different actors in the supply chain like original equipment remanufacturers (OEM) or original equipment suppliers (OESs), third parties, like independent remanufactures (IR) or subcontractors/contracted remanufacturers (CR). For that reason, in the literature there are studies on the generic models for the remanufacturing process. One of the most referenced is the model by Sundin (2004) who identities generic processes in remanufacturing, as follows: inspection, cleaning, disassembly, reprocessing, re-assembly, testing and storage. The flow of materials in the remanufacturing process includes used or discarded products (known as cores), the new parts and the components from cannibalized products.

[6] Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Technical guidelines on transboundary movements of electrical and electronic waste and used electrical and electronic equipment, in particular regarding the distinction between waste and non-waste under the Basel Convention, Appendix 2: Glossary of Terms. edited by COP 13: United Nations Environment Programme, 2017

According to the report (IRP, 2018) The main obstacles to upscale the value recovery processes in the EEE sector result from:

- Regulatory barriers related to the availability and access to cores on EEE markets (for example restrictions on WEEE classification as e-waste, restriction on import-export of VRPs products)
- Collection Systems Barriers – related to the configuration of WEE reverse logistics network with strong focus on the recycling processes, thus making VRPs difficult (for example: EOU products mixed and damaged during collection and transportation).
- Economic and technological barriers: Limited know-how on VRPs related technologies and skills, combined with the growing number of multiple models and generations of EEE, make it difficult to build up capabilities for cost-efficient, and environmentally friendly operations (low economy of scale).
- Customer-related barriers – related to customer purchasing behavior and preferences for new products, resulting in limited willingness-to-pay for VRPs products.
- Market-related barriers – lack of standards, certifications, and misinformation about VRPs products.

1.3. Research methodology

The framework aims to support the scaling up of remanufacturing in PaaS settings especially on the consumer markets (Business to Customer B2C). The framework takes into consideration the resource-based view and process view.

The resource-based view assumes that a company's internal resources can be a potential source for building competitive advantage. Barney (1995) defined a company's internal resources as all the financial, physical, human and organizational assets used/owned by an organization to develop, manufacture and deliver products or services to customers. The VRIO framework states that an organization can succeed in its business model if its resources are characterized by value, rarity, imitability, and organization (Barney, 1995). When transitioning to a circular business model, it is important that human resources (such as: people's knowledge and skills), natural resources (e.g., water, air, raw materials), and technical resources (such as, e.g., buildings, machinery, tools, means of transportation) are limited and must be used effectively in business processes. In the era of global competition, where a product, production process or supply chain structure can be easily copied, one of the few areas where companies can continue to excel over the long term is human resource management. Employees have the potential to develop a sustainable competitive advantage leading to long-term organizational sustainability (Darcy et al., 2014). The organizational change theory approach to sustainable business development emphasizes that the more companies prioritize sustainability, the more it needs to be integrated into the core business (Sroufe, 2017). The external and internal drivers and barriers of transformation shall be considered with the role of so-called change agents within the company (Kiesnere & Baumgartner, 2019). In attempting to deal with the growing complexity of sustainability challenges, forward-thinking leaders (so-called change agents) can influence vision, strategy, new products, processes and supply chain integration, fostering collaboration and innovation across functions and throughout the value chain.

In this research, we aim to identify the key resources which are necessary to scale up the remanufacturing in PaaS settings. We look into the process flow perspective to identify the main challenges to make remanufacturing resource efficient, so called Lean & Green.

In order to find the limitations of the current approaches and provide the guidelines for scaling up the remanufacturing in PaaS settings, we apply the exploratory qualitative approach. We combine, the findings from systematic literature review with the expert's opinions, media listening, review of the industry reports and primary and secondary data from case studies.

We develop the previous studies of Östlin et al. (2008) who proposes to analyze the remanufacturing in the context of closed loop from:

- the external perspective: take-back system, relationships with customers and suppliers,
- the internal perspective: remanufacturing process management (material and information flow) within the company.

Our methodology is presented in Figure 3.

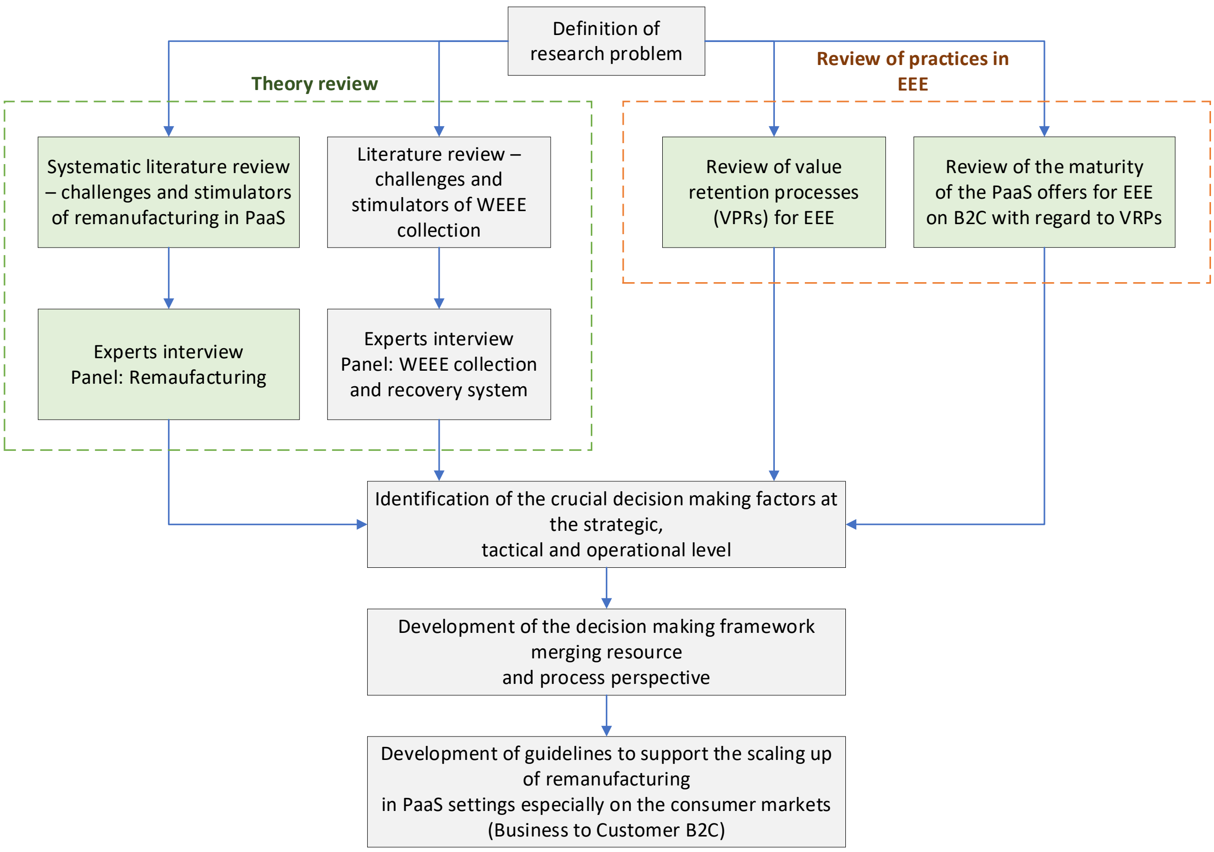

Figure 4. Research methodology

The methodology included review of the theory (research string TRS), and practice (research string PRS) with regard to the PaaS offerings (the circularity of business model), EEE/WEEE collection system (external perspective) and remanufacturing (internal perspective). During case studies secondary and primary data were analyzed (see Table 2).

Table 2. Description of the research methodology used for developing of the decision-making framework

Step	Research string	Purpose	Output	Methods and tools	Remarks /feedback
TRS 1	Remanufacturing for EEE	Identification of main challenges and stimulators, formulation of the research gaps and research issues	List of challenges and stimulators for upscaling reman in PaaS settings within the categories: • legislation/policy; • customer & market; • product; • supply chain & RL; • servitized business model • process	Systematic literature review (PRISMA)	ICPR 2023 Presentation and feedback
TRS 2	WEEE take back system	Identification of main challenges and stimulators	List of challenges and simulators with categories: • legislation /policy; • technology; • customer; • product-related, • economy, • reverse logistics processes	Critical literature review, content analysis	ICPR 2023 Presentation and feedback
PRS 1	Value retention processes for EEE/WEEE	Review of the OEM current practices	Economic Social Environmental dimensions of the current practices - gap identification	Gap analysis with SWOT, multiple case studies, exploratory case study	Master Thesis 1 & Master Thesis 3

Step	Research string	Purpose	Output	Methods and tools	Remarks /feedback
PRS 2	PaaS with EEE for B2C	Review of the current practices	Maturity assessment of current offers with regard to R-strategies - gap identification	Maturity model theory, multiple case studies	Master Thesis 2
EO1	Expert's interviews - remanufacturing	Assessment of the Output from TRS 1	Identification of the key factors for decision model (internal perspective)	Semi structured expert's interviews (5 experts)	Expert's workshops
EO2	Expert's interviews - take back system (external perspective)	Assessment of the Output from TRS 2	Identification of the key factors for decision model (external perspective)	Semi structured expert's interviews (10 experts)	PaaS workshops
DF 1	Design of structure of decision-making framework	Merging resource and process perspective	Identification of key elements of the framework	GAP Analysis	Expert's workshops
DF2	Design of the guidelines for upscaling remanufacturing in PaaS		Guidelines	GAP Analysis, critical literature analysis	

The description of the finding from each of the research strings is provided in the subsequent chapters.

2. Review of remanufacturing of EEE – challenges and drivers for scaling up remanufacturing in PaaS settings

Remanufacturing is an industrial process in which a core (returned product) is disassembled, reprocessed and reassembled in order to bring it back to at least "as good as new" condition (Sundin, 2004). Returned products typically encompasses: manufacturing defects/quality returns, obsolete inventory, end-of-life products, end-of-use products, warranty returns, commercial surpluses. Companies remanufacture products for various reasons, as follows (modified from Seitz, 2007; Ostlin et al. 2008):

- Securing spare parts supply for warranty and servicing purposes;
- Protecting market share and brand;
- Providing novel aftermarket solutions;
- Fulfilling environmental legal obligations;
- Increasing profits;
- Fulfilling CSR policy;
- Reducing costs;
- Enabling green marketing.

Remanufacturing is a common way to provide replacement parts for warranty services or the aftermarket. It is also used in the case of Product-Service-System agreements to facilitate the life-cycle management of products.

There are perquisites for developing the remanufacturing system in a company, such as (Vogt Duberg et al., 2020):

- Core supplies (acquisition) and reverse logistics system;
- Labor skill and availability of human resources;
- Remanufacturing facilities and their proximity to key markets, and partners in a supply chain, which influence the decision on centralized or decentralized value retention processes;
- Remanufacturing process and technology (e.g., machines, tools, devices and IT systems).

Furthermore, the remanufacturing capabilities can be enhanced by (Vogt Duberg et al., 2020):

- Design for remanufacturing and information feedback;
- Lean management;
- Product-as-a-service business models (e.g., PaaS).

In traditional remanufacturing, the common problem is core (which is End-of-Use or End-of life products) acquisition. The problems with availability of sufficient quantity of good quality cores appear on open markets (e.g., for automotive components).

Offering PaaS for customers (specially in B2C) might help to overcome this challenge, as the ownership of the core remains with a producer and the duration of the PaaS offering can be managed to capture to optimal value of a product and to minimize the cost of remanufacturing (due to good quality of core). Furthermore, the integration of remanufacturing with product design can lead to the extended life of product, and modular design could help to easily upgrade goods, and to reduce the cost of repairs and recovery at a component level. The long-term data to assess those benefits is still missing to investigate full picture (challenges and benefits in monetary units). The example of white good manufacturers shows that there are a number of challenges, which shall be further explored and investigated in close cooperation with companies to provide actionable and feasible tools and solutions. The Product-as-a-Service allow to reshape the core acquisition and reverse logistics practices, as the PaaS provider (preferably OEM) obtains the knowledge of when and how many products enter the remanufacturing process which make it easier to plan and manage remanufacturing process (Sundin & Bras, 2005).

The combination of PaaS and product remanufacturing provides opportunities for the circularity of EEE products to become economically and environmentally beneficial to the value network actors. However, there are a number of challenges that need to be taken into consideration when designing the decision-making framework to scale up remanufacturing with PaaS solutions. The summary of the findings from systematic literature review is presented in Table 3. The focus was placed on the applicability of the findings to the management of remanufacturing process in PaaS settings.

The barriers and drivers for the development of remanufacturing of EEE in PaaS are classified here into six categories, based on the previous research of Nasr et al. (Nasr et al., 2018):

1. related to the product;
2. related to the regulations and policies;
3. related to the customer and market;
4. related to the servitized business model characteristics;
5. related to the characteristics of remanufacturing (or comprehensive refurbishment);
6. related to the take-back system (reverse logistics).

Table 3. Summary of the findings from the systematic literature review

Category	Barriers	Source	Drivers	Source
Product (P)	**PB1. Limited durability and quality of EEE for B2C**	(van Loon et al., 2018, 2022; van Loon & Van Wassenhove, 2018)	**PD1. Feedback loop with customer to improve design and durability – user-centric design**	(Arredondo-Soto et al., 2022; Brissaud et al., 2022; Moro et al., 2021)
	PB2. Limited design for disassembly & reassembly of EEE	(Duflou et al., 2008a; Nasr & Thurston, n.d.; Russell & Nasr, 2023; Sakao & Mizuyama, 2014; Sakao & Sundin, 2019)	**PD2. Increased easiness to disassembly and modularity of EEE for B2C**	(Duflou et al., 2008b; Goodall et al., 2014; Jensen et al., 2019; Khan et al., 2018; Reuter et al., 2018; Vanegas et al., 2018)
	PB3. Shortening of use cycle-technological innovations	(Bressanelli, Saccani, Perona, et al., 2020; Khan et al., 2018; van Loon & Van Wassenhove, 2020)	**PD3. Smart digital technology to monitor use patterns and plan preventive maintenance**	(Bressanelli et al., 2018; Bressanelli, Saccani, Pigosso, et al., 2020; Wang et al., 2022)
Policy and legislation (L)	**LB1. Strong focus on recycling target for WEEE for B2C**	(Cucchiella et al., 2015; Neto et al., 2023; Parajuly & Wenzel, 2017)	**LD1. Push in policy for extended durability and reparability**	(Dalhammar et al., 2021; Krystofik & Gaustad, 2018)
	LB2. Lack of taxation benefits for PaaS with reman/refurbish	(Bressanelli et al., 2019a; Svensson-Hoglund et al., 2021; Yang et al., 2019)	**LD2. Eco-design regulations**	(Jensen et al., 2019; Sakao & Sundin, 2019)

	LB3. Lack of standards for reman/refurbish for EEE in B2C	(Bressanelli et al., 2017, 2019a, 2019b; Svensson-Hoglund et al., 2021)	**LD3. Circular Economy Policies with PaaS and reuse**	(Bressanelli, Saccani, Pigosso, et al., 2020; Kjaer et al., 2018; Krystofik & Gaustad, 2018; Pan et al., 2022)
Customers & market (C)	**CB1. Limited knowledge on the reman /refurbish EEE**	(Arredondo-Soto et al., 2022; Bressanelli et al., 2022; Gülserliler et al., 2022; Hunka et al., 2021; Patwa et al., 2021)	**CD1. Extended product warranty and hassle-free product usage**	(Alqahtani & Gupta, 2017; Arredondo-Soto et al., 2022; Bressanelli et al., 2022; Liao et al., 2015; Maronick, 2007; Schallehn et al., 2019; Vogtlander et al., 2017)
	CB2. Limited willingness to pay for reman/refurbish EEE	(Bressanelli et al., 2022; Gülserliler et al., 2022; Hunka et al., 2021; Patwa et al., 2021)	**CD2. Access to functionality of EEE without initial purchase cost**	(Bressanelli et al., 2017, 2019b; Jensen et al., 2019)
	CB3. Limited acceptance, low demand for reman/refurbish EEE	(Bressanelli et al., 2019a, 2022; Gülserliler et al., 2022; Hunka et al., 2021; Patwa et al., 2021)	**CD3. Total cost of ownership distribution over time (e.g., subscription fee)**	(Kambanou & Sakao, 2020; Saccani et al., 2017; van Loon et al., 2022)
Servitized business model (S)	**SB1. Additional cost of administration of PaaS, cash flow problems**	(Lieder et al., 2018a; van Loon et al., 2020, 2022; van Loon & Van Wassenhove, 2018)	**SD1. Feedback loop with customers to iteratively improve PaaS offering**	(van Loon et al., 2018, 2022; van Loon & Van Wassenhove, 2020)

	SB2. Lack of actionable tools for jointly evaluation of economic benefits for OEMs and customers	(Kambanou & Sakao, 2020; Kurilova-Palisaitiene, 2021; van Loon et al., 2018, 2020; van Loon & Van Wassenhove, 2018; Vogt Duberg et al., 2020)	**SD2. Control over product use cycles (chance to optimize value in cascade CE model)**	(Bocken et al., 2018; Bressanelli et al., 2017; Duberg et al., 2021; Jensen et al., 2019; Pialot et al., 2017)
	SB3. Lack of actionable tools for jointly assessment of environmental benefits for OEMs and customers	(Bressanelli et al., 2017, 2019a; Kambanou & Sakao, 2020; Kurilova-Palisaitiene, 2021; van Loon & Van Wassenhove, 2018; Vogt Duberg et al., 2020)	**SD3.Economic benefits from servitization (new revenues streams/access to new markets/shortening sale channels)**	(Agrawal et al., 2011; Arredondo-Soto et al., 2022; Bressanelli et al., 2022; Jensen et al., 2019; Kjaer et al., 2019; Lieder et al., 2018b; Lindahl et al., 2014; Opresnik & Taisch, 2015; van Loon & Van Wassenhove, 2020)
Process perspective (VRP)	**VRB1. Limited/no experience in VRPs for EEE**	(Kurilova-Palisaitiene, 2021; van Loon et al., 2022; van Loon & Van Wassenhove, 2020)	**VRD1. Reduced uncertainty of timing, quality, quantity of returns thanks to the OEM's ownership of EEE (lowering reman costs)**	(Intlekofer et al., 2010; Kurilova-Palisaitiene, 2021; Opresnik & Taisch, 2015; Pialot et al., 2017; Russell & Nasr, 2023; Sundin & Bras, 2005; Widera & Seliger, 2015)

	VRB2. Limited access to skilled staff	(Kurilova-Palisaitiene, 2021; van Loon et al., 2022; van Loon & Van Wassenhove, 2020; Vogt Duberg et al., 2020)	**VRD2. Economic benefits from use of EEE in multiple contracts**	(Bressanelli et al., 2017, 2019a; Jensen et al., 2019; Kurilova-Palisaitiene, 2021; Liao et al., 2015; Tukker, 2015b; van Loon & Van Wassenhove, 2018; Vogt Duberg et al., 2020)
	VRB3. Linear mindset, fear of cannibalization of sale of new products	(Bressanelli et al., 2019a; Raz et al., 2017; van Loon et al., 2022; van Loon & Van Wassenhove, 2020; Widera & Seliger, 2015; Yang et al., 2019)	**VRD3. Resource-efficiency by using value embodied in EEE**	(Alqahtani & Gupta, 2017; Bressanelli et al., 2017, 2019a; Intlekofer et al., 2010; Jensen et al., 2019; Kurilova-Palisaitiene, 2021; Nasr & Thurston, n.d.; van Loon & Van Wassenhove, 2018; Vogt Duberg et al., 2020)
	VRB4. High costs- difficult to achieve the economy of scale in reman of EEE on B2C	(van Loon et al., 2018, 2020, 2022; van Loon & Van Wassenhove, 2020; Widera & Seliger, 2015)	**VRD.4. Environmental benefits and green branding**	(Agrawal et al., 2011; Bressanelli et al., 2022; Jensen et al., 2019; Pialot et al., 2017; Vogtlander et al., 2017)
Supply chain & reverse logistics (RL)	**RLB1. High cost of establishing own take-back system (collection, transportation & testing)**	(Bocken et al., 2018; Krystofik & Gaustad, 2018; Lieder & Rashid, 2016; Prajapati et al., 2022; Tukker, 2015b; Vogt Duberg et al., 2020)	**RLD1. Subsidies to organize take back systems**	[16,49, 50,58]

	RLB2. Need for new partnerships in configuration of RL	[16,49, 50,58]	**RLD2. Resilience in a supply chain**	(Jensen et al., 2019; Pialot et al., 2017)
	RLB3. Country-specific constrains on transborder transportation of used EEE/WEEE	(Anandh et al., 2021; Brito et al., 2022; Svensson-Hoglund et al., 2021)	**RLD3. Cooperation between different actors**	(Brito et al., 2022; Hansen & Revellio, 2020)

3. Review of practices & identification of the key factors for scaling up remanufacturing in PaaS settings

Product-as-a-Service on the consumer markets (B2C) currently is a niche (Sakao et al., 2023). In the framework of this research nine offers for household appliances were identified on the EU market. The offers were reviewed with regard to the application of the R strategies. The R- strategies are crucial for the application of the circular business model's (Kirchherr et al., 2017), in order:

- To use and manufacture smarter (Rethink, Refuse, Reuse);
- To expend the products and parts lifespan (Repair, Reuse, Refurbish, Remanufacture, Repurpose);
- To provide application of material (Recycle, Energy Recovery).

The detailed description of the cases is provided in (Golinska-Dawson et al. 2023)[7]. All of the analyzed offers, provide relatively low level of application of the cascading model, and focused on the recycling and partial service value retention processes (see Section 1.2), such as reuse in multiple PaaS, and repair after the usage phase. Remanufacturing and incremental refurbishment were the least used approaches (see Figure 5).

Figure 5. Application of the R strategies in the analyzed PaaS offerings,
Source (Zysnarska, 2023)[8]

The review of the current practices was also followed by the expert's interviews on the applicability of R-strategies for EEE/WEEE.

[7] Golinska-Dawson, Zysnarska Z., Pender A. (2023). Assessment of the maturity of product-as-a-service business models for household appliances from the perspective of R strategies in Circular Economy. Submitted to CIRP LCE 2024.

[8] Zysnarska Z., (2023). Assessment of the maturity of PaaS (Product-as a Service) business models for the households appliances in the framework of Circular Economy. Master thesis written under supervision of Golinska-Dawson P. for SCANDERE project, Poznan University of Technology, Poznan, Poland

According to the experts the current system is strongly focused on the recycling activities due to the high recycling target and not sufficient availability of the end-of-use good quality cores. Almost half of all discarded waste of electrical and electronic equipment (WEEE) in Europe is not properly collected and recycled and is unreported by the EU member states (Habib et al., 2022). The reason for this is relatively low engagement of customers, who often dispose of WEEE in household waste or store it at home (so called hoarding). Another contributing factor may be thatthey get recycled, but not under compliant conditions for WEEE. In order to prolong the life duration of EEE, a newly introduced proposal for 'right to repair' can play an important role, as it will facilitate increased availability of spare parts or easier access to cost-effective repair and upgrading services for ICT and electronics[9]. Reducing allows for using fewer natural resources, raw materials, energy, and waste to increase resource efficiency (Morseletto, 2020). Furthermore, in the EEE sector, the reduce strategy can also mean the extension of product life, which allows for replacement of products less frequently (Blomsma et al., 2019).

The results of the experts (Panel EO2: Expert's interviews - take back system, 10 interviews with a duration of 90-150 minutes) done in this WP of Scandere have shown, that the improvement of the take-back system might be one of the main stimulators for development of remanufacturing in EEE sector. The experts have in particular risen to need for implementing solutions, such as:

- visual inspection of (W)EEE at the collection;
- sorting at the collection;
- W(EEE) collection points and multiple ways for consumers to dispose of (W)EEE should be further developed;
- distinguishing at the collection between EEE and WEEE, in order to avoid administrative burden related to WEEE;
- developing the remanufacturing and repair processes with usage-based models - PaaS, leasing, renting, subscriptions, sharing - should be promoted among consumers.

The experts have also mentioned the need for developing new partnerships and subsidizing the take-back system in order to make it more cost-efficient.

The results of the systematic literature review on remanufacturing (Table 3) were further triangulated with the results of the five expert interviews (EO1: Panel remanufacturing). The interviewed experts were involved in the industrial cases (each interview lasted 60-120 minutes). Furthermore, the triangulation process included the authors' reflections on industrial cases they

[9] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1794 (accessed on 24 March 2023)

previously conducted (with remanufacturing in circular business models). The triangulation process confirmed the SLR findings. The additional challenges that were addressed by the experts were:

- Financial difficulties in providing feasible cash flow for scaling up the PaaS. T
- Need for new financial partnership models, as at the beginning of PaaS contract, as the production, logistics and administration costs are incurred by providers, but the future revenue stream is spread over a long period of time due to the nature of the servitization.
- Need for increased participation and collaboration in a supply chain.
- Need for tools and methods for calculating the joint economic and environmental benefits and costs for PaaS providers and customers.
- Need for well-established sectoral quality & safety standards for remanufactured EEE.
- Lack of know-how and large-scale applications – best practices are missing

In order to initiate remanufacturing in a company without prior remanufacturing experience, Vogt Duberg et al. (2023) propose the 5-step framework (5AFIR), which recommends to (1) to select a product family, (2) to involve of actors which are crucial for remanufacturing, (3) iteratively identify prerequisites and assess the system performance, (4) develop industrialize remanufacturing, and (5) refine and validate.

We consider the simplified version of 5AFIR approach to initiate the remanufacturing in PaaS. First, the choice of products for PaaS shall be made with regard to their potential for circularity. Then the perquisite for the EEE remanufacturing on B2C market are reviewed as presented in Table 4.

Table 4. Perquisite for the EEE remanufacturing on B2C – CoLAR analysis framework

Perquisite[10]	Current implementation	Experts' assessment	Enforcing circularity in PaaS
Core availability & reverse logistics system	very low/low	Current collection for B2C is volume oriented, all the products are collected & transported together. There is no visual inspection or assessment of the technical state of EoU/EoL products (they become WEEE).	Need to build capacities and partnerships for EEE collection in a selective way with inspection & quality pre-assessment.
Labor skills & availability of staff	low	Remanufacturing is very labor-intensive. The required set of skills is much broader than in production of EEE. It takes 6-12 months to train an employee for EEE reman/refurbish. There is a shortage of employees for remanufacturing. The linear mindset of managers is a challenge.	Need for training of employee to develop the remanufacturing skills. The production workers in most cases don't have skills to commence reman. Need to extend the servicing network or to build partnerships with independent remanufacturers.
Access to the market and activization of key actors	low/medium	The awareness of availability or reman products is low, thus demand is very low. There is lack of common understanding on what is a remanufacturing/refurbishment product. There is no industry recognized quality and safety standards for EEE on B2C. The willingness to pay for reman product is lower than for new products. It is difficult to achieve economy of scale and provide economic viability of EEE remanufacturing on B2C. There is high competition from cheap & low quality new EEEs.	Need for building the customers' awareness about PaaS and reman products. Building direct channels of communication with customers for PaaS offering. Need for new approach to administration of PaaS which secures the return of products at the end of PaaS contracts, and which protects from product misuse or extensive use.

[10] The CoLAR analysis framework is based on the perquisites identified by (Vogt Duberg et al., 2020)

Perquisite[10]	Current implementation	Experts' assessment	Enforcing circularity in PaaS
Remanufacturing, process technology & equipment (machines, tools, devices and IT systems).	low/medium	The know-how on remanufacturing of EEE for B2C is very limited. Most OEM are not involved in remanufacturing operations. The cost of the remanufacturing process due to low economy of scale is higher than manufacturing new product. The non-destructive disassembly of EEE is tricky, due to the linear product design.	Need to provide tools for the assessment of economic and environmental benefits for both OEM and customers. Need for resource - efficient reman process design (lean and green)

4. Design of structure of decision-making framework

The decision-making framework structure reflects the levels of decision making in a company/supply chain, namely strategic, tactical and operational (Figure 6).

The **strategic dimension** can be divided into external and internal perspectives The internal perspective focuses on decision making for the development of the circular business model with value retention processes. The external perspective is related to the creation of a favorable landscape in which the PaaS with value retention processes can be embodied. The review of the business practices from the EEE sector have shown that currently most of the PaaS offering do not apply the full potential of the cascading model. The existing regulations prioritize the recycling of WEEE. There are numerous barriers for the development of PaaS offers with value retention processes (which have been indicated in Section 1.2 of this report). For this reason, the **tactical dimension** of the framework focuses on enforcing the circularity in PaaS. The **operational dimension** of the framework focuses on designing the resource-efficient remanufacturing process, with focus on overcoming the identified barriers and enforcing the stimulators (drivers) impact. The lack of remanufacturing experience and potentially high remanufacturing costs are often a concern for companies when transitioning from linear to circular business models. Establishing efficient and lean remanufacturing processes is one of the main challenges facing linear producers today.

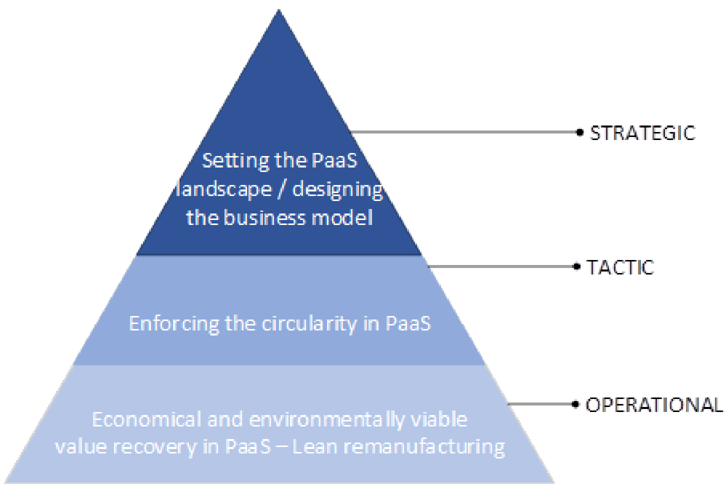

Figure 6. Dimensions of the decision framework

Decision support frameworks shall support companies in their transition to PaaS business models with remanufacturing. The findings from the literature review (see Chapter 2) were combined with the insights from review of industrial cases. Only very few of the analyzed scientific papers provide evidence-based recommendations for scaling up EEE remanufacturing in the consumer market within PaaS offerings. The existing research is fragmented, and the presented case studies are in the initial stage of development or implementation (pilot projects). Reducing barriers is critical to activate the drivers of change for scaling up economically viable and environmentally beneficial remanufacturing for EEE in PaaS for consumer markets. There is a gap between the current state of small-scale PaaS implementations for EEE on B2C markets and the desired state of large scale applications. Moreover, the existing solution does not implement the broad portfolio of R-strategies which are crucial to enforce the circularity. The journey to the desired state of PaaS with remanufacturing (or in the broader perspective with cascade model for optimum value retention) is presented in Figure 7.

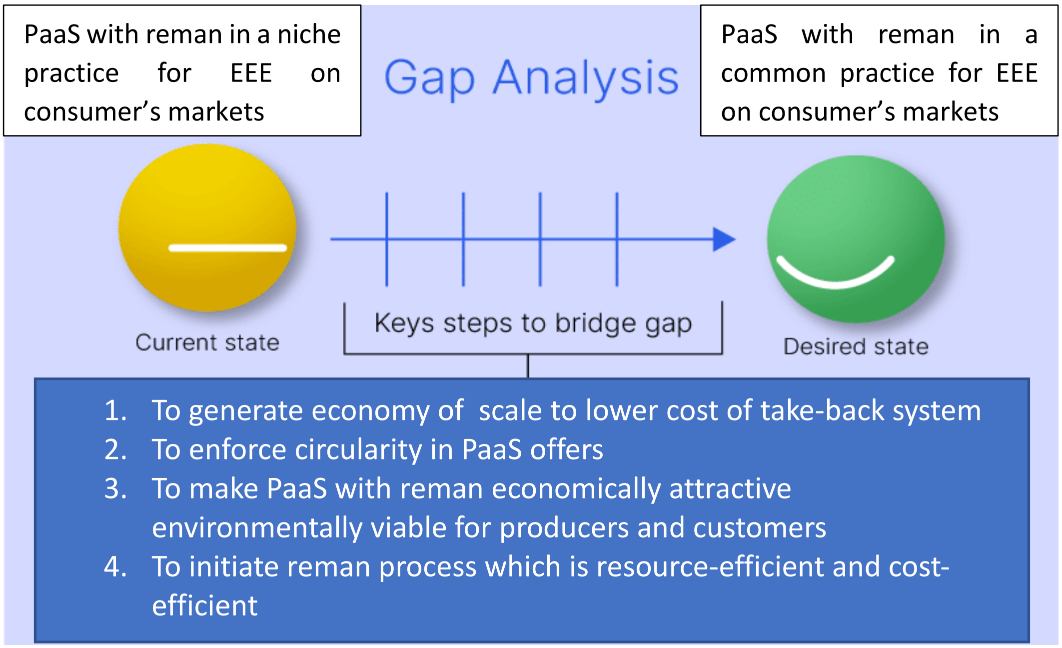

Figure 7. Gap to bridge

In the current WEEE regulations in European Union, the emphasis in the take-back system is placed on the collection and recycling of EEE. The recovery rate is defined on the aggregated levels, thus most of the producers are not involved in the reverse logistics themselves and delegate it to some specialized third-parties. From the remanufacturing perspective, the main challenge is the way the WEEE are currently collected, as products of different types from different producers are mixed and often they are damaged during the collection process. Such a situation is not acceptable from the point of view of remanufacturing, as quality and availability of core (economy of scale) influences significantly the cost and possibilities of remanufacturing. Scaling up of the PaaS will need building some new partnerships in the EEE industry and re-designing the reverse logistics network. Further challenges will be optimizing the additional costs of shipping and core evaluation prior the remanufacturing.

The acceptance of remanufactured products differs between markets and customer segments (Gülserliler et al., 2022). The research shows that the education of the customers is important to maximize the chance for success and scaling up of the PaaS offering (Zhou et al., 2021). Previous studies have shown that in case of conventional sales (van Loon et al., 2020), consumers perceive remanufactured products as of lower quality. Therefore, their wiliness to pay the full price is lower for remanufactured products than new products (Kleber et al., 2018). To establish an economically viable model, customers must return products at the end of the PaaS offering in good condition and on time (van Loon & Van Wassenhove, 2018), as it is crucial to reduce the costs of remanufacturing and to achieve the economy of scale. IoT devices may be useful in collecting and processing data on customer behavior to diagnose the current condition of a device, so assessment can be made before end of PaaS contract. The research and practical applications are badly needed to support future decision-making on most preferable recovery scenario in PaaS (e.g., full scale remanufacturing, repair, cannibalization for components or recycling).

The technological innovation may make remanufacturing of EEEE unviable option as older generations of remanufactured products may not be attractive to customers (e.g., too high energy or water usage). For the transition of companies to PaaS model, the development of new tools for assessment of the most economically and environmentally viable option for product recovery is crucial. To enforce the circularity in PaaS offerings proactive management of product life cycle is needed. This is crucial to collect product at the optimal time, with high retained value (EoU not EoL).

PaaS can offer the customers a hassle-free use of EEE, as the maintenance and service costs are covered usually by the PaaS provider. However, perceived benefits should not be overestimated, so different options may need to be offered for different customer segments, such as pay-per-use, multiple leases for new or remanufactured/refurbished products (Bressanelli et al., 2019b).There is a challenge to jointly optimize costs for producers and customers (total cost of ownership TCO), as PaaS needs to be financially attractive and viable for both. In the ideal conditions, the PaaS model assumes several contracts with customers with remanufacturing/refurbishing in-between the contracts to return a product to its full functionality or upgrade it to the current market standards (e.g., energy efficiency) by changing modules or software. The costs of remanufacturing and repairs are borne by the producers, who therefore need to optimize their tools with the help of a life cycle costing LCC approach. Setting correctly the PaaS fees for a cascading model with few leasing contracts (with remanufacturing in between) requires a big set of data and analytic tools, and that is at the moment challenging, as most of the PaaS in the B2C markets are small-scale pilots (van Loon et al., 2022). Establishing efficient and lean remanufacturing processes is one of the main challenges for linear.

	STRENGTHS	WEAKNESSES
INTERNAL FACTORS	+ Control over cores + Possibility to bene fit from multiple cycle of use of product + Building long time relations with customers – feedback to the design of product + Increasing brand loyalty + Keeping ownership of EEE (out of WEEE regulations) + Shorter supply chain	– Complexity and cost of collection and assessment processes before reman/refurbish (new model and partnerships needed) – Lack of tools for assessment of economic and environmental benefits for both OEM and customers – Costs of reman/refurbish to residual value of products – Supply chain structure focused on recycling – Lack of skilled people – High variability of products on the markets
	OPPORTUNITIES	**THREATS**
E XTERNAL FACTORS	+ Circular shift in regulations + Digital technologies and IoT + Shifts in consumption behavior towards more sustainable + Pilot and R&D projects in the sector on WEEE Value retention processes (VRPs) and PaaS	– Regulation on take back and collection (competition from recycling or reuse) between countries – Linear economy bias in the sectors (current business models are not ready to adjust to CE) – Lack of customer acceptance and willingness to pay – Competition from recycling targets – Technological innovations speed and energy/water efficiency expectations

Figure 8. SWOT analysis

In order to bridge the gap between the as-is and the preferable future state (to- be), it is necessary enforce the strengths and to mitigate the impact of the weaknesses. To do so, a decision-making framework for PaaS with remanufacturing is proposed on Figure 9.

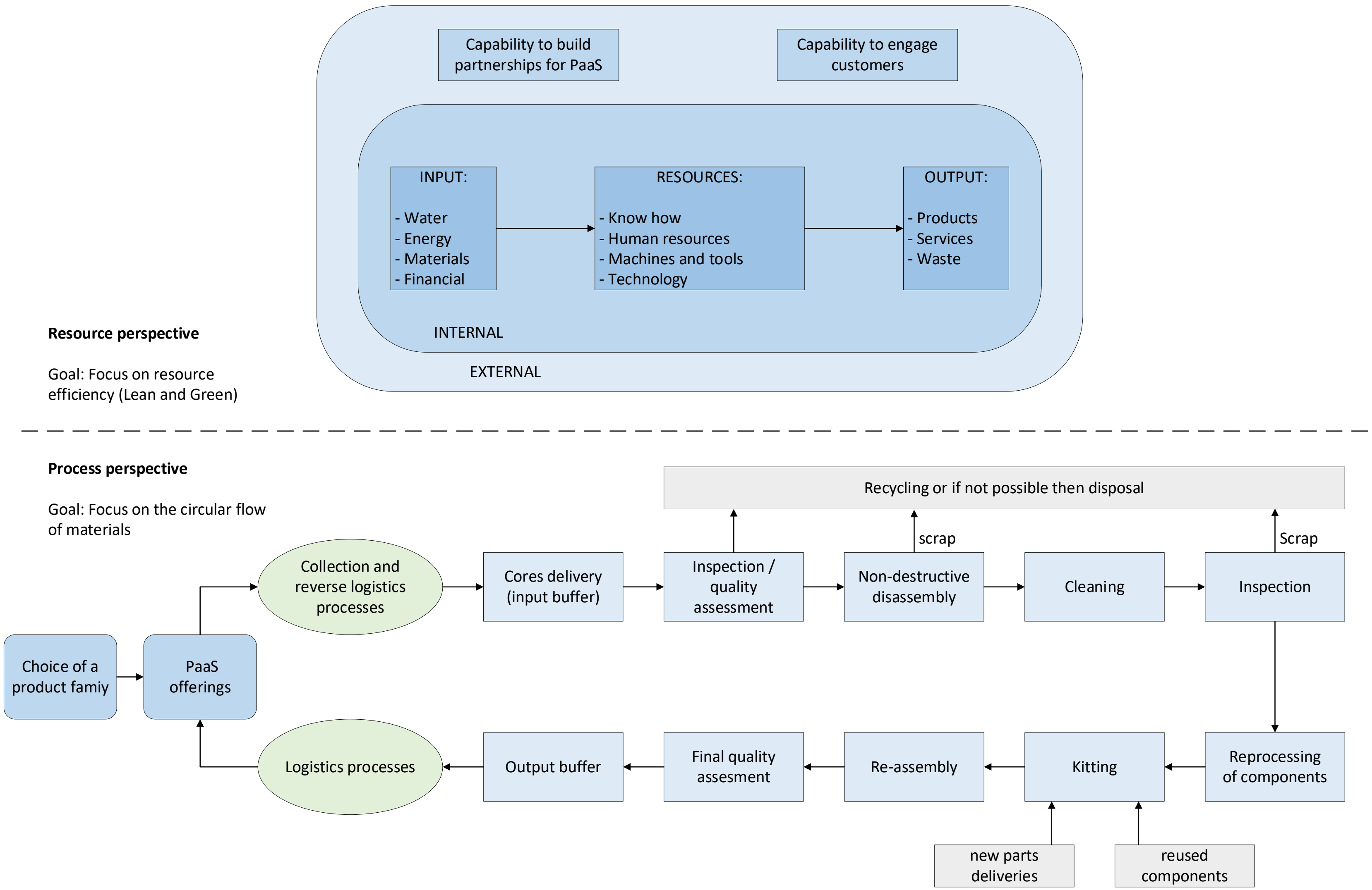

Figure 9. Decision making framework

5. Guidelines for scaling up the potential of remanufacturing in PaaS with EEE

The guidelines for the implementation of the proposed decision-making framework are presented in Table 5. Abbreviations used in the table:

- S strategic level of decision making – long term
- T tactical level of decision making – medium term
- O operational level of decision making – short term
- E external – actions to be taken by external body
- I internal – actions to be taken internally by PaaS provider
- KPIs – key performance indicators
- IoT- Internet of Things devices
- IPRs – intellectual property rights
- N/A not applicable

Table 5. Guidelines for the development of the DF for scaling up PaaS with remanufacturing

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
Choice of product family: Increasing product remanufacturability	S	E	Sectoral product quality standards for Remanufactured/refurbished EEE	Lobbying, systemic actions from the industry associations	Lobbying, systemic actions from the industry associations	To be defined
	S	E	Including the circularity measures related to remanufacturing in the policy for Extended Producer Responsibility	Lobbying, systemic actions from the industry associations	Lobbying, systemic actions from the industry associations	Target values for reman/refurbish in WEEE directive
	S	E	Beneficial taxation benefits for remanufactured products	Lobbying, systemic actions from the industry associations	Lobbying, systemic actions from the industry associations	To be defined
	T	I	Product manufacture for VRPs	Choice of materials and components which are sufficient quality for at least one VRPs cycle when developing new product/or re-lifting the existing one	Crucial but dependent on OEM	To be defined
	T	I	Product design for easy non-destructive disassembly	To adopt easy to disassembly joints for a non-disruptive disassembly, preferable semi-automatic,or robotic to achieve economy of scale in long term.	Crucial but dependent on OEM	To be defined
	T	I	Product prone to technical obsolesce due to modular design and software upgradability	To adopt modularity structure to gain economic benefits due to reduced components damages and less work-load needed for upgrades.	Crucial but dependent on OEM	To be defined

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
	T	I/E	Availability of product related information	Increasing access to information from usage phase (e.g., with IoT). Currently the feedback loop with customers is non-existent in most of cases as the point of contact with customers are retailers and servicing organizations (outsourced)	Digital product passport might significantly increase access to the data, but the issue related to protection of know-how and IPRs must be solved. IR don't have information they learn by dissembling product or searching online.	To be defined
	T	I/E	Good availability of cost-effective spare parts	Capacity building in the supply chain, partnerships with suppliers, use of remanufactured components for servicing, repairs and VRPs.	Capacity building in the supply chain, partnerships with suppliers, use of remanufactured components for VRPs	To be defined
Reshaping the take back system	S	I/E	Development of cost-efficient technologies for remote and proactive monitoring of the condition of the EEE/WEEE before collection	Capitalizing more than 1 cycle, educating customers to use products responsible (to reduce risk of misuse), include customers in self-monitoring of the "state of health" of the EEE in PaaS by access to user friendly mobile apps.	Building partnership with PaaS providers, building trust for data sharing, development of common information exchange standards.	To be defined
	S	I/E	Partnerships for collection of WEEE/EEE	Developing new channels for collection of products returned form PaaS .	Developing partnerships with PaaS providers.	To be defined
	T	I	New cost-efficient and scalable solutions for take back of the products	Developing credit back system to increase the collection rate.	Centralized collection, inspection facility and then transportation to reman	To be defined

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
				Dedicated easy to apply collection boxes in continent location. Usings retailer's network and let them to inspect and collect. Develop the standardized guidelines for inspection at retailers.	facilities (contracted or own)	
	T	I	Build capacities for quick and cost-efficient inspection of the quality of returning products	To develop check-list and easy manuals on how to quickly assess the quality of returning products Training staff for visual inspection	To develop check-list and easy manuals on how to quickly assess the quality of returning products Training staff for visual inspection	
			Optimizing the reverse logistics costs	Include the transportation cost in the PaaS offering calculation and discount it though duration of the offer	Shortening the supply chain to collect information from suppliers	
Building capability to engage customers	S	I	Build the customer awareness of PaaS and reman products	Invest in building the awareness to consumers. Economic benefits might be not there in the transition period, but communication on the environmental must be highlighted to make it attractive	Inform customers how long product will last. Promoting reman is has to be clear on performance and how it is done.	To be defined
	S	E	Increase customer's willingness to pay for reman product	Communicate the environmental and economic benefits provide clear communication.	Inform customers how long product will last. Promoting reman is has to	To be defined

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
					be clear on performance and how it is done.	
	S	I	Build up direct channels for communication with customers and feedback loop mechanism	Developing cost-efficient online platforms to link with the customers. Translating strategy in the simple indigents which customer will understand.	Developing cost-efficient online platforms to link with the customers	To be defined
	S	E	Subsides for the organization of collection systems	Lobbying, systemic actions from the industry associations	Lobbying, systemic actions from the industry associations	To be defined
Developing Servitized Business Model	S	E/I	Build cooperation with external financial partner	As revenue is postpone, there is need for external financial partner to mitigate the cash flow problem in the transition period.	N/A	To be defined
	T/O	E/I	Lower administration costs of servitized models	Need for a new administration model. Automate and simplify the information flow between PaaS provider and customer. Use of standardized form, and external partners for payments management	N/A	To be defined
	T/O	E/I	Lower cost of maintenance and servicing	Standard guidelines for servicing Outsourcing Use of reman /reuse spare parts if possible Self-diagnosing devices	N/A	To be defined

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
	T/O	E/I	Tools for environmental and economic assessment of the PaaS offers	Developing tools which are linked to management support system.	N/A	To be defined
	S	I	Developing strategy for transition from linear to circular model	Timing of the transition, the participation of the right people/departments, defining transparent KPIs	N/A	To be defined
	S/T	I	Generating revenue streams over more than one lifecycle of products	Applying subscription models, proactive management of the duration of the contract, simplification of the administrative procedures	N/A	To be defined
TDeveloping Remanufacturing process organization and technology	S	I	Design of the cost-efficient and environmental viable reman processes for EEE	Building the know-how on remanufacturing technologies. Defining the remanufacturing process phases for EEE Building long term commitment of the management towards remanufacturing Defining the remanufacturing/refurbishing level (full, partial etc.)	Improving the know-how, developing technologies, equipment and software	To be defined
			Location of facility	Decision on centralized/decentralized location of remanufacturing operations Inhouse remanufacturing or outsourced.	Decision on centralized/decentralized location of remanufacturing operations	

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
	T/O	I	Building the capabilities of staff for reman	Sensibilization and training of staff to build up know-how for remanufacturing Organizing employee cross-training and learning through problem solving	Continuous training of staff on new EEE types and designs, reverse engineering Organizing employee cross-training and learning through problem solving	To be defined
	T	I	Improving the economy of scale of reman processes	Engaging in the cooperation with independent remanufactures	Achieving the sufficient input (good quality cores in required amounts)	To be defined
	T/O	I	Improving the organization and planning of the process	Implementing standard operations, instructions or/and checklists	Implementing standard operations, instructions or/and checklists	To be defined
	T/O	I	Improving the process flow	Design of the layout of remanufacturing facility according of lean principles Implementing continuous flow	Design of the layout of remanufacturing facility according of lean principle Implementing continuous flow.	Lean based
	T/0	I	Lowering the cost of remanufacturing in comparison to residual value of products	Application of lean practices in the process flow	Application of lean practices in the process flow	To be defined
	T/O	I	Proactively managing the input of cores	Proactive management to duration of the PaaS contract, Proactive monitoring of the state of health, defining criteria/check list for premature	Building partnerships with PaaS provider to lower waiting for information on incoming core	To be defined

Decision making factor	Level	E/I	Needed actions	OEM remanufacturing	Third party remanufacturing	KPIs
				ending of PaaS/exchanging product for newer one. Improving information flow to reduce waiting for information on incoming core.		
	O	I	Cost-efficient inventory management	Avoiding the unnecessary storage of core.	Avoiding the unnecessary storage of core. Proactive management of the products portfolio.	Inventory rotation Inventory levels

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