Reuse of ICT devices as commons: A property rights and governance model for collective access

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Understanding the role of property rights in managing Information and Communication Technology (ICT) devices, primarily computers, is fundamental to addressing resource waste and achieving digital inclusion and sustainability goals. Although the acquisition, use, and disposal of ICT devices are predominantly governed by private property, reuse ecosystems demonstrate significant benefits. In such ecosystems, diverse actors collaborate to recover discarded ICT devices, refurbish, maintain, and deliver them at minimal environmental and economic cost. Drawing on the Common-Pool Resources theory, this article proposes a model that employs property rights to govern ICT device reuse, using the bundle of rights as a structured language to organise reuse ecosystems. The model is based on the eReuse initiative, developed by researchers from the Technical University of Catalonia and the non-profit organisation Pangea, in Spain. It captures patterns of collective action, classifies actors by their roles, and maps the property rights underlying the interactions among these roles. The model was formalised to ease its application in Latin American contexts and evaluated in three regional reuse ecosystems to assess its suitability for replication. Results indicate that, although local adaptation is often needed, the eReuse model is considered suitable for informing the design of *ad hoc* models to manage the property rights of reused ICT devices in culturally aligned reuse ecosystems.

CCS Concepts: • **Social and professional topics → Sustainability**; *Computing / technology policy*; *Governmental regulations*; • **Human-centered computing → Collaborative and social computing**; • **Hardware → Impact on the environment**.

Additional Key Words and Phrases: property rights, governance model, reuse of ICT devices, circular economy, collective resources, sustainable development goals.

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1 Introduction

The use of ICT devices, especially computers, can play a catalytic role in helping address climate change, for instance, by automating processes. However, the demand for increasingly powerful and diverse devices accelerates the cycle of production, consumption, and disposal of still functional

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devices, which produces significant adverse effects on the environment [8, 14, 15, 36]. At the same time, access to ICT devices reflects deep structural inequalities. While the average internet user globally owns more than six digital devices, including smartphones, tablets, and consoles [6], 50.3% of households worldwide lacked a computer at home at the onset of COVID-19 [37].

Such disparity arises from how ICT devices are conceptualised. Considering the classical goods theory [47], ICT devices can be classified as private goods, defined by their economic exclusivity (i.e., the access is limited by the ability to pay) and their rivalrous nature, since their use by one person prevents simultaneous use by another [33]. This classification shapes their economic circulation and determines property rights, understood as the authorised actions concerning a resource [59]. These rights act as a mechanism that establishes how and under what conditions people and organisations interact with resources and the environment. Depending on their allocation, they generate positive or negative externalities that affect third parties not directly involved in using these resources.

In contrast to approaches centred on individual property, which reflect how ICT devices are usually consumed, community-based ICT reuse models offer alternatives for managing property rights. Typically, these latter are implemented as ICT reuse ecosystems, which go beyond both state-led and purely market-driven logics, combining principles of Circular Economy (CE) [18] with the values of the Social and Solidarity Economy (SSE) [66]. Their practices, regarded as institutional innovations, significantly extend the lifespan of devices and foster fairer access, particularly for vulnerable populations. From this perspective, ICT reuse ecosystems can be understood as situated within the "safe and just space" proposed by the doughnut economic model [53], as recently adapted to the global ICT context by the United Nations [44].

To investigate how these ecosystems operate and what makes them effective, this paper focuses on the governance structures that underpin them, and especially on the types and configurations of property rights involved. We expect that by modifying the excludability of ICT devices, we can transform them from private goods into commons, i.e., resources that are rivalrous in use yet exhibit low excludability as defined by Becker and Ostrom [9]. Although ICT devices are traditionally understood as private goods, they may acquire characteristics of a commons when rights, such as management in the second-use phase, access, and use, are redistributed and collectively governed.

Building on this foundation, the article applies Ethnographic Action Research (EAR) within eReuse [21], a reuse ecosystem comprising multiple organisations operating across Spain since 2016. eReuse functions as a living laboratory for experimenting with alternatives to individual ownership. This study presents the eReuse model and illustrates how property rights can be redefined within a collective framework.

To assess the potential of the model for supporting ICT reuse ecosystems in regions culturally similar to Spain, we analysed the applicability of the eReuse model in two Latin American countries, particularly in two initiatives in Argentina and one in Uruguay. This analysis was supported by existing literature, highlighting the need for locally adapted property frameworks that help operationalise ICT reuse policies effectively [31, 38]. Moreover, tailoring reuse ecosystems to the socioeconomic and technological realities of developing countries is essential for alignment with global sustainability goals [2, 60].

The article is organised as follows. Section 2 reviews related work on property rights and governance in the CE. Section 3 outlines the methodological approach used to explore the eReuse initiative, defines the data collection process, and presents an analysis of the actors and property rights involved. Section 4 formalises the eReuse property rights governance model, its core design principles, and empirical findings from Spain. Section 5 analyses the suitability of the model in informing the design of property rights and governance models for three specific Latin American ICT reuse initiatives. Section 6 discusses broader implications in light of the literature. Finally, Section 7 concludes by summarising contributions, limitations, and future directions.

2 ICT devices: private goods and reuse challenges

Integral to contemporary society and embedded in countless aspects of daily life, desktop and laptop computers are treated as private and excludable goods [33]. Market forces and their associated economic returns prevent many individuals from gaining instrumental access to these devices. According to International Telecommunication Union (ITU) data, 90.5% of households in least developed countries lacked access to computers, compared with 61.5% in developing countries and 17.7% in developed countries in 2019 [37]. This disparity contributes to the digital divide [68].

The paradox lies in the fact that, although ICT devices are both rivalrous and excludable, they are often recycled prematurely due to rapid software evolution [27, 39] and accelerated depreciation that encourages early replacement [67]. Under individual property models, their first-use lifespan is typically estimated to be between 3 and 5 years [3, 30, 51].

Direct and assisted reuse arise as alternatives to extend the lifespan of these ICT devices. However, their implementation depends on the regulatory frameworks in place in each country or region. Assisted reuse, in particular, relies on Extended Producer Responsibility (EPR) systems that require manufacturers to take responsibility for the collection, reuse, and recycling of their products. In the absence of such systems, informal recycling practices often prevail, usually with adverse environmental and social consequences [8].

In the European Union and other regions, manufacturers are required to finance the treatment of discarded devices, including their preparation for reuse (PfR), as established by Directive [25]. Nevertheless, official data shows that only 2% of e-waste collected in Europe in 2012 was reported as PfR and direct reuse [11]. Unlike PfR, where devices are legally considered waste and subject to strict treatment obligations, direct reuse preserves their status as products. This distinction reduces the administrative burden and facilitates redistribution through community-based initiatives.

2.1 Conceptual foundations for collective management of ICT devices

To address these limitations, we turn to the conceptual foundations of commons governance. Rivalry, excludability and premature recycling offer a valuable opportunity to rethink the management of ICT devices in the context of direct reuse, CE and SSE. These devices can also be conceptualised as commons, i.e., resources that are collectively managed outside the logic of the market or the state. Commons are defined not only by shared access and limited excludability, but also by the governance arrangements, that is, the rules that regulate their use and preservation [45]. These rules are known and recognised by the actors involved, and may be either *de jure* (formal and legally codified) or *de facto* (informal but socially accepted).

The relationship between resources and collective management is directly connected to the concept of property, and more specifically, to property rights. In legal theory, particularly within the Anglo-American tradition, property is not defined as the object itself, but as a set of separable and transferable rights that may be distributed among different actors or concentrated in one. When a single actor holds all these rights, the configuration constitutes full exclusive ownership [35].

Schlager and Ostrom expanded this perspective by providing empirical evidence [46], alongside theoretical models, and proposed a detailed classification of property rights defined as a bundle of rights [59] comprising *access*, *withdrawal*, *management*, *exclusion*, and *alienation*. These rights are distributed across five right-holder positions: *authorised user*, *authorised entrant*, *claimant*, *proprietor*, and *owner*.

The authors specify that in common property settings, property rights are the practical outcome of the rules adopted by communities to govern the use of common resources, in contrast to individual ownership, where rights are fixed, predetermined, and externally defined. Rules are thus fundamental not only in defining rights, but also in preventing the overexploitation of resources

and the tragedy of the commons [32], which, in the case of ICT devices, refers less to depletion than to premature disposal and underutilisation. The bundle of rights is dynamic and context-dependent, emerging from the interactions among the actors and the evolving needs of the community.

The concept of Common-Pool Resources (CPR) systems extends this understanding of goods and property by incorporating not only the characteristics of the resource itself but also the institutional arrangements that enable its collective and sustainable management [45]. CPR systems, whether natural or human-made, are resource systems from which multiple users can appropriate units, often for individual benefit, while the system remains collectively governed. ICT devices can therefore be seen as man-made CPR systems; for example, a computer may circulate among several users while remaining under governance structures that preserve its value. This duality between individual gain and collective stewardship underscores the importance of rules, both formal and informal, as well as the role of social capital and trust in enabling coordinated action among users [52, 57]. These conceptual foundations provide the basis for analysing real-world ICT reuse ecosystems, such as eReuse, which operationalise commons governance through the redistribution of property rights, showing how reduced excludability can transform private goods into commons.

2.2 Commons governance in digital and circular ecosystems

Initiatives such as Guifi.net in Catalonia, Spain, and Zenzeleni in South Africa show how commons-based principles can be applied in the digital domain to manage community-based Internet infrastructures through distributed governance [7, 54]. This shift in governance models also extends to circular contexts, going beyond natural resources to focus on preserving value in circular systems [49]. In these ecosystems, public, private, and civil society actors collaboratively design rules to transform formerly residual resources into valuable assets through circular strategies [10, 48].

While a few recent studies support the use of the rights-bundle theory as a tool for redistributing responsibilities and rethinking waste management in industrial ecosystems, its practical application remains scarce [62, 63]. In this sense, this paper presents a way to operationalise the bundle of rights, aiming to overcome the limitations that hinder the implementation of this governance approach in ICT reuse contexts.

Although the literature on CE applied to ICT device reuse highlights several benefits, such as reducing the carbon footprint by prolonging device lifespans [3, 34], promoting digital inclusion [69], and generating local green jobs [56], these outcomes depend on specific conditions rather than occurring automatically. Environmental gains require that reused devices effectively substitute new ones; otherwise, rebound effects arise, offsetting the expected benefits [40, 70]. Digital inclusion demands not only access but also digital literacy, technical support, and adequate devices [24, 29, 50, 64]. Green job creation, in turn, depends on the fulfilment of both previous conditions. When these interdependencies are ignored, the impacts are treated as discrete and additive, missing the systemic nature of ICT reuse. This fragmented perspective constrains the potential of CE strategies to deliver integrated and equitable outcomes, precisely the kind of potential unlocked when property rights are redistributed through commons-based governance.

3 Exploration of the eReuse ecosystem

eReuse is a collaborative initiative that captures discarded ICT devices from public and private organisations, refurbishes them via local SSE, and recirculates these devices at circularity cost [21]. The daily operation of eReuse is supported by *ad hoc* software tools developed collaboratively by its own community to enable ICT device reuse traceability, data for accountability and social reporting to donors, and systematic documentation of property rights transitions [20, 23]. These tools are available as open-source software.

The structure, processes and instruments used in eReuse were shaped through four stages, performed between 2016 to 2024. Every stage represented an evolution for this ecosystem and involved joint work with the stakeholders. In terms of the property rights definition, in the first stage, we conceived a collective action agreement jointly with the Barcelona City Council. This agreement legally validated property-rights transfers and standardised workflows among public donors, refurbishment centres, distributors, maintainers, and intermediary organisations. Then, in the second stage, the agreement was extended to private donors. The third stage was used to refine contractual clauses and extend the supporting software tools, based on feedback from the participants after four years of operation. Finally, the fourth stage involved adjusting the governance model to include new clauses that address emerging stakeholder needs.

The organisations involved in this evolution process are listed in Appendix A (see Table 7) classified according to their roles within the eReuse ecosystem. Next, we explain the exploration and data gathering processes; then, we present an analysis of actors and property rights considered in eReuse.

3.1 Exploration method

The eReuse initiative was explored using EAR [65], as the first two authors have been involved in this initiative since 2016. This allowed us to access the records of eReuse (i.e., qualitative and quantitative information) and also many actors in this ecosystem. Moreover, this method combines the sustained perspective of ethnography, capturing everyday governance practices, negotiations, and lived experiences shaping property rights, with the iterative cycles of action research, aligning inquiry with the evolving needs of the initiative. This dual perspective enabled both analytical depth and practical impact, as insights were generated through co-design, collaborative experimentation, and continuous reflection. This qualitative research approach was complemented by using quantitative data from eReuse supporting software tools, which provide information about device flows and property rights transitions for each device, providing a holistic basis for defining and formalising the governance model.

3.2 Data collection processes

3.2.1 Qualitative data gathering. To coordinate and document activities about the definition, adjustment and management of property rights of ICT devices, an agile strategy was implemented using Taiga's Kanban module. This enabled iterative task management and thematic tagging across various actor categories. Transitions in the eReuse process for each device donor were recorded and classified in real-time through multi-level tags, ensuring granular traceability. In line with EAR principles, multimodal data (e.g., field notes, meetings, documents, and recordings) were logged and tagged in Taiga, while the most relevant outputs from each cycle were archived in a chronologically and thematically organised Nextcloud repository. This dual system ensured granular traceability in real-time and provided a stable analytical foundation for synthesis and reflection. Data analysis was conducted through thematic coding of these materials, focusing on property rights relations, which enabled the identification of recurring patterns and tensions among requirements from different stakeholders.

3.2.2 Quantitative data gathering. Quantitative information was generated through two open-source tools maintained by the eReuse team: Workbench [23] and DeviceHub [20]. The first one is a bootable USB application for diagnostics, data wiping, and hardware/software identification. The second tool is a web service for device inventory and lifecycle management, which records property transitions and issues compliance documentation.

Table 1. Actors in the eReuse ecosystem.

Actor Id	Role Description
A1	Devices manufacturers
A2	Organisations donating discarded devices
A3	Extended Producer Responsibility (EPR) agents
A4	Authorised waste managers
A5	Second-hand device users
A6	Second-hand ICT managers
A7	Refurbishment centres
A8	Public actors setting policies and regulations for device reuse and recycling
A9	Second-hand device distributors
A10	Second-hand device maintenance technicians providing services under servitisation models (i.e., business models that shift from product ownership to service provision)
A11	Intermediary organisations providing access to ICT devices (e.g., classrooms, training centres)
A12	ICT agents and mentors who provide accompaniment and guidance to users

Quantitative data were collected from devices processed at three refurbishment centres: Solidança [61], Donalo [17], and Alencop (now part of Andròmines [5]). While representative of eReuse practices, these centres do not cover the whole network. They operate under a data-sharing licence (CC BY 4.0) and use Workbench and DeviceHub to manage device information throughout their chain-of-custody, i.e., the documented tracing of each device across refubishment and reuse stages.

Inventory exports were then processed in the R language for cleaning, transformation, and descriptive statistical analysis. The anonymised device specifications [55] were used to trace lifecycles, compare reuse and recycling rates by donor type, and estimate economic utility through the eReuse use-value algorithm [26].

3.3 Analysis of actors and property rights

The previously collected information allowed us to analyse how five core property rights (*exclusion*, *access*, *withdrawal*, *management*, and *alienation*) are distributed across the ICT eReuse actors ecosystem. Such information also indicated that twelve types of actors (A1–A12) participate directly or indirectly in the eReuse processes. Table 1 lists the actors in terms of the role that they perform.

Table 2 links the actors to rights holders, and their corresponding rights, clarifying how responsibilities and control are distributed across the ICT reuse ecosystem. Actors A1, A3, A4, and A8, although relevant in the ecosystem for setting the broader context, do not directly exercise property rights within the governance model; therefore, they are not included in Table 2.

Finally, Table 3 integrates all previously introduced components into a comprehensive mapping, explicitly linking actors, property rights holders, and rights through institutional arrangements. This visualisation succinctly illustrates how these elements interrelate within the governance model, enhancing comprehension of property rights dynamics.

The latest versions of the property rights agreements are publicly available through the eReuse portal, incorporating the insights generated during this fieldwork. These agreements are openly accessible [19], thus enabling the reuse of these artefacts.

Table 2. Actors and rights holders defined in our context.

Actors	Rights holders	Right	Description
A2	*Proprietor*	*Exclusion*	The organisation that originally bought a new ICT device retains control over its allocation, setting conditions on beneficiaries, requesting impact reports, and determining how *access* and *withdrawal* rights may be granted.
A5	*Authorised user*	*Access*	A beneficiary user is granted permission to regularly use an ICT device under specific conditions, with the right to access it physically or remotely for non-subtractive activities (e.g., reading documents, browsing the web, checking emails).
A11, A12	*Authorised entrant*	*Withdrawal*	Hold limited rights to access devices for infrastructure, operational stability, and user support, without personal use interest.
A9, A10	*Claimant*	*Management*	Hold limited rights over second-hand devices, including configuring usage, performing hardware/software upgrades and maintenance, and transferring devices to *authorised users*.
A6, A7	*Owner*	*Alienation*	Refurbishment centres and second-hand ICT managers have *alienation* rights over devices and may transfer other rights (*access*, *withdrawal*, *management*). This enables them to recycle devices outside the ecosystem or reallocate them publicly, provided that the donor has explicitly specified this option.

4 Formalisation of the eReuse property rights governance model

Figure 1 closes the empirical mapping, serving as a visual synthesis of the governance model, illustrating the interactions among the different actors (shown in Table 1) and the transitions of the property rights. It distinguishes individual from collective property rights, showing how shared rights and coordinated decision-making sustain the social and environmental viability of the eReuse ecosystem. Next subsection indicates how the distribution of property rights supports transitions from individual to collective rights distribution.

4.1 From private to common property rights

In this subsection, we discuss the shift from individual to collective property rights in the proposed model, highlighting key differences in how these rights influence ICT device transfer, use, and management. We first outline how property rights operate under individual property scenarios and then contrast them with eReuse's property rights governance.

As shown in Figure 1, the process starts in the individual property scenario, where ICT devices pass from manufacturers (A1) to donor organisations (A2), EPR agents (A3), or authorised waste managers (A4). Authorised waste managers can carry out PfR, converting what is declared as waste into a resource/product (P1). Moreover, an end-user (A5) receives the second-hand device as individual property, as in second-hand shop business models (e.g., backmarket).

Direct donations (P2), with a transfer of individual property rights, can also take place directly from the donors (A2) to the end-user (A5) or intermediary initiatives (A11). However, this direct transfer faces significant barriers, including concerns over data security, proper data wiping, regulatory compliance, accountability in device management, and doubts about the devices' actual reuse potential.

Fig. 1. Property rights governance model for ICT reused devices.

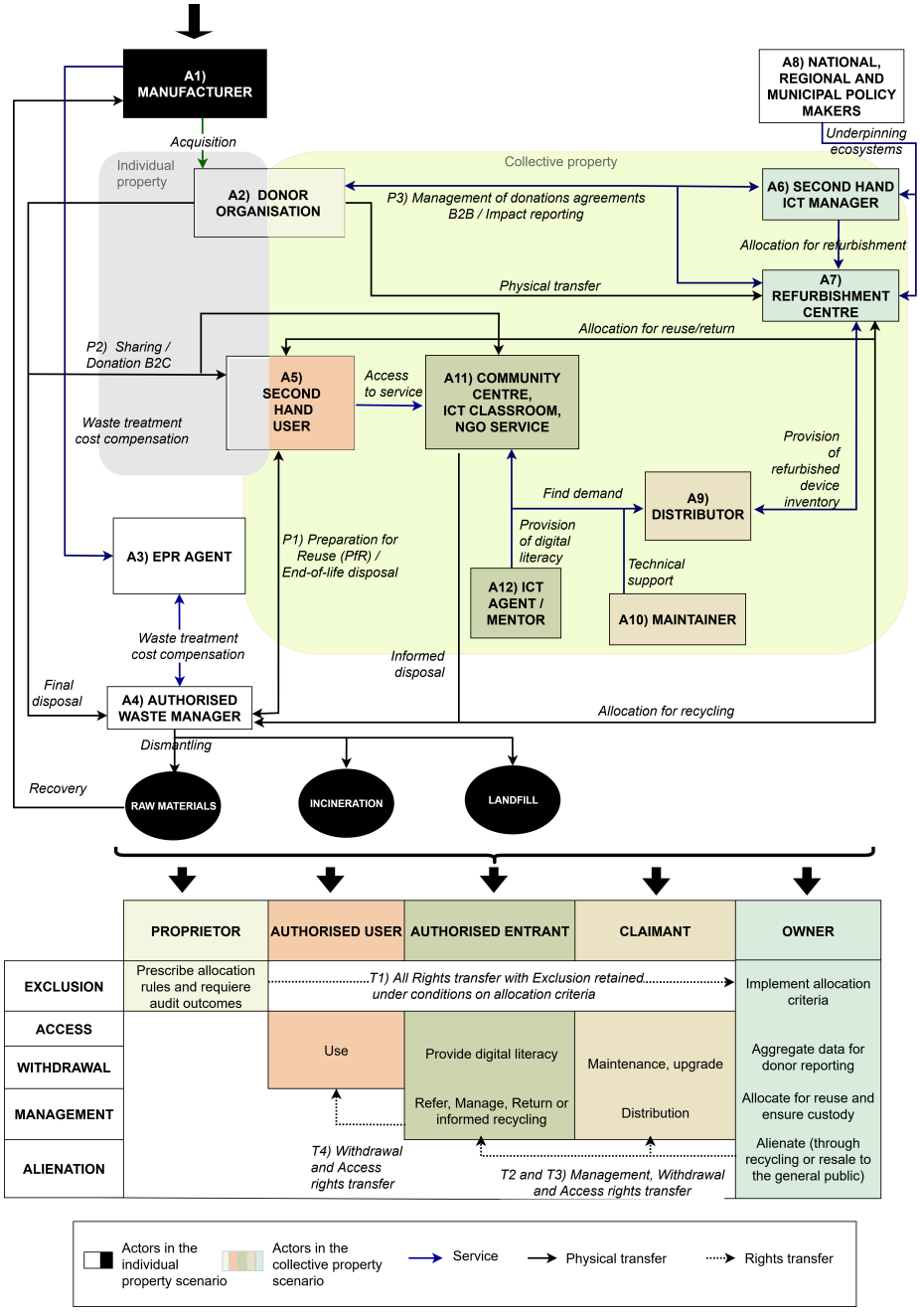

Table 3. Rights holders, actors and rights in the mapping of roles and rights to actors in the model.

Rights holders	*Proprietor*	*Authorised user*	*Authorised entrant*	*Claimant*	*Owner*
Specific actors	Donor organisation (A2)	Second-hand user (A5)	Intermediary organisations, ICT agents and mentors (A11, A12)	Distributors, maintenance technicians (A9, A10)	Second-hand ICT managers, refurbishers (A6, A7)
Rights - Part of the property bundle					
Exclusion	Yes: can define broad conditions for allocation	No	No	No	Yes: collective rules prescribe which *authorised user*
Access	No	Yes	Yes, limited	Yes, limited	Yes, no interest
Withdrawal	No	Yes	Yes, limited to guest	Yes, no interest	Yes: operational use, no direct interest
Management	No	Limited: can manage own user account	Yes	Yes: allocation, maintenance	Yes: refurbishment, repair, recycling
Alienation	No	No: cannot transfer or sell	No	No	Yes

In the collective property scenario (P3), donors supply devices to the ecosystem, typically still considered a product, supported by public policies (A8) and income-generating mechanisms. In practice, eReuse may charge fees to cover circularity costs or provide servitised ICT classrooms to administrations, as tested in pilot projects.

Consistent with the view of property as a divisible legal construct [35] and the typology of rights [59], the model shows how rights are distributed across actors. In individual property, a single actor holds the full bundle of rights. In contrast, under collective property, these rights are distributed among multiple actors, forming a flexible bundle that governs the CPR.

Property rights are exercised in varied ways; for instance, the bundle of rights applied to a set of ICT devices from a given donor encompasses the rights and rules for their use and management. In addition, transfer formal agreements (indicated as T1–T4 in Figure 1) enable donor organisations to redistribute parts of this bundle to other ecosystem actors. These collective rules are widely known and determine who may make decisions, which actions are permitted or prohibited, and which procedures should be followed. Below we summarise how each rights holder exercises their part of the bundle.

4.1.1 Proprietors. Donor organisations (A2) relinquish all rights upon donation, except for the right of *exclusion*. This allows them to set criteria for ICT refurbishment centres and end-users, thereby designating them as *proprietors*. In practice, these organisations provide minimal information on device condition, characteristics, and data-wiping standards at the request of refurbishment centres (A7). Financial compensation is required from *proprietors* for non-reusable devices or data-wipe services, and it also restricts non-reusable materials either by rejecting them or by

requiring compensation. This allows for balancing the donation's net value against the associated administrative overhead, making donor agreements highly dynamic. Additionally, some *proprietors*, as part of their environmental and social responsibility policies, mandate feedback on the impact of reuse and recycling, prompting the eReuse ecosystem to maintain detailed records of its operations, actors' participation, and final reuse and recycling outcomes.

4.1.2 Owners. As shown in Figure 1, donors transfer the key rights (T1) to second-hand ICT managers (A6) and refurbishment centres (A7). This enables these actors to manage devices comprehensively, from certifying data wiping and maintaining chain-of-custody to collection, refurbishment, and distribution. Notably, the *alienation* right allows the *owners* to remove devices from the system for recycling when the reuse potential is low. When coupled with the transfer of *exclusion*, the *owner* permits the ecosystem to market devices publicly. For instance, in eReuse, if no demand for a device is detected within one month, the device may be offered to the general public.

In practice, refurbishment centres (A7) are responsible for the technical processing and documentation of devices, e.g., their collection, transport, triage, data wipe, inventory, and refurbishment. Meanwhile, the second-hand ICT managers (A6) secure donations, coordinate transfers, and report impacts, often under multi-year agreements that ensure inflow.

4.1.3 Claimants. To ensure the distribution and preservation of device value, the *management* right is transferred (T2) from the second-hand ICT manager (A6) and the refurbishment centres (A7), to distributors (A9) and maintenance actors (A10); these actors are *claimants*. In eReuse, refurbishment centres share inventories of already refurbished devices with distributors that use marketplaces, e-commerce, and social networks to secure agreements with intermediary organisations. Also, eReuse collaborates with external maintenance technicians under servitisation models, responsible for updating the hardware and open-source software and handling incident resolution.

4.1.4 Authorised entrants. Owners or *claimants* transfer *management*, *withdrawal*, and *access* rights (T3) to intermediary organisations (A11). These latter can access devices, usually through unrestricted use or compensation of circularity costs, and assign them to end-users (A5), as long as they follow exclusion rules set by donors. These organisations act as facilitators, providing structured access to ICT resources. Additionally, ICT agents and mentors (A12) support users by offering guidance, training, and accompaniment in the effective use of devices, ensuring that technology adoption translates into real social benefits.

The *authorised entrants* sign a *de jure* use cession, or servitised agreements. These agreements typically include clauses requiring the return or recycling of the device once it is no longer needed, obliging users to maintain the device in good condition. Although *authorised entrants* have functional access to the device, they do not hold *alienation* right (i.e., they cannot resell the devices).

4.1.5 Authorised users. End-users (A5), who are direct beneficiaries of NGOs, municipal programmes, or who visit public spaces such as libraries or community centres (i.e., intermediary organisations), gain *withdraw* and *access* rights to computers via *authorised entrants* (T4), becoming *authorised users*.

4.2 Understanding actors interaction

Building on the quantitative data obtained from the Workbench and DeviceHub tools, and documented in [55], this subsection analyses how collective governance and device management dynamics operate within the eReuse ecosystem. By tracing 1,616 ICT devices across reuse and recycling flows (715 were reused and 901 recycled), we examined the interaction among 38 donor organisations (5 public and 33 private), three refurbishment centres, and 97 intermediary organisations.

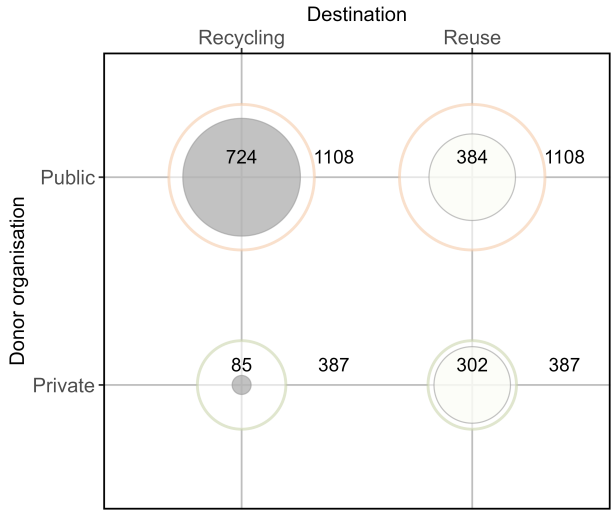

Fig. 2. Destination and donated volume of devices by type of donor organisation.

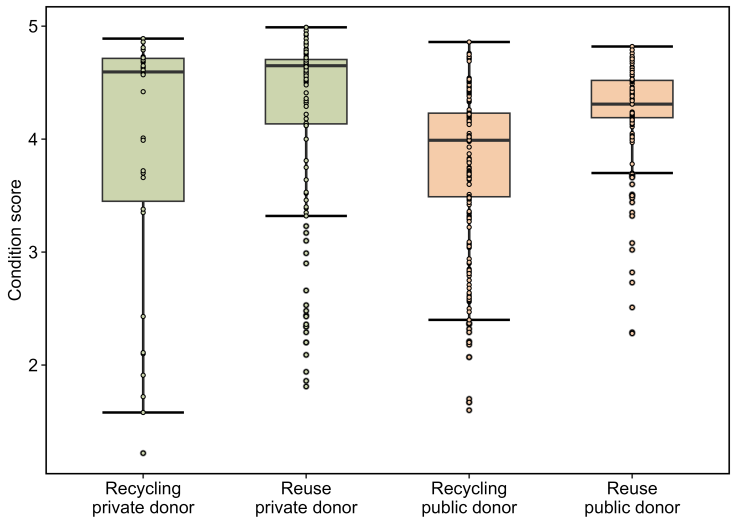

Fig. 3. Boxplot with condition score (computational power) of use of devices (X-axis) categorised by destination and type of donor organisation.

This analysis compares reuse and recycling flows by donor type. It links them to device performance and institutional agreements, providing empirical insights into how device characteristics, actor roles, and governance practices influence reuse outcomes. It also illustrates how the ecosystem continuously adapts to ensure economic and environmental sustainability.

As shown in Figure 2 (based on the subsample with complete data), 45.9% of all donated devices were successfully reused and allocated. However, notable differences emerge in the reuse rates between public and private donor organisations. Devices received from public donors had a reuse rate of 34.6%, whereas those from private organisations reached a reuse rate of 78%. This figure highlights the comparatively low reuse rates in the public sector. At the same time, these organisations contribute a larger volume and frequency of donations, but the quality of their devices often results in misalignment between supply and demand, affecting their reuse and recycling expectancy ratio in the ecosystem.

Further analysis of the computational power of these devices, as captured by the DeviceHub tool, provides insight into the observed disparities (Figure 3). The sample of devices with complete data on categorical information regarding the processor, RAM, and HDD reveals that those received from private donors usually have higher computational power than those from public organisations. This trend can be explained with the insights gained from semi-structured interviews performed to these organisations, which indicate that many public institutions, including the Barcelona City Council, have extended the internal use of devices beyond their accounting amortisation periods, as a way to mitigate their environmental footprint.

Even after undergoing data wiping and chain-of-custody procedures, devices from public organisations often remain in storage because they only operate on open-source software, limiting their appeal to potential users. Although recycling is an option, the benefits do not offset the additional costs incurred during these processes. Therefore, the low reuse ratio of ICT devices from public donors has prompted eReuse to re-evaluate its operational procedures and criteria.

In response, adjustments are being implemented to assess better the viability of reusing older devices and to optimise the balance between refurbishment and recycling, aiming to enhance overall economic sustainability. For example, as previously noted, strategies such as opening the demand for devices to the general public were implemented when no targeted demand is observed after one month. Moreover, servitisation has emerged as a promising approach, since the donor not only contributes devices to eReuse, but also actively participates in generating demand for those ICT resources, while simultaneously redistributing risks and responsibilities among actors. This model underscores that it is strategically more viable for public organisations to engage on the demand side of the refurbished market, rather than merely supplying outdated devices.

The low reuse ratio of ICT devices from public organisations, coupled with the challenge of balancing a steady supply of quality devices with sufficient demand from intermediary organisations willing to cover the costs of circularity, has prompted significant changes in eReuse practices. These adjustments reflect the ongoing adaptive process, characteristic of CPRs, that strives to ensure long-term economic sustainability.

5 Suitability of the property rights and governance model

The suitability of the property rights and governance model was then evaluated in three Latin American contexts, as a way to determine its potential for generalisation in other ICT reuse ecosystems culturally similar to eReuse. These ecosystems were Nodo Tau [43] and Ekoa [42] in Argentina, and Antel Integra [4] in Uruguay. All of them share a focus on increasing the digital inclusion of unserved communities through the reuse of ICT devices.

In November 2022, we conducted fieldwork at these ICT reuse ecosystems, combining site visits, focus groups, semi-structured interviews, and document analysis with policymakers, managers, technical staff, and community representatives (Appendix A). Similar to the eReuse exploration process, we documented the project activities and outputs using Taiga and Nextcloud, ensuring traceability and facilitating the identification of recurring property rights patterns. This enabled us to identify similarities with eReuse, explore cross-cutting patterns, and validate information

on governance, collaboration, and operational practices. Table 4 summarises the main features of these ecosystems.

5.1 Characterization of the explored ecosystems

These initiatives started operations at different times and evolved at different paces. Until today, they keep several differences in terms of the source of devices to be reused (item 4 in Table 4), and the operational constraints they have to address to fit with their regulations (items 5-7). For instance, while Ekoa and Antel Integra primarily rely on direct public support and the allocation of refurbished devices without associated service fees, eReuse and Nodo Tau, despite receiving some subsidies and financial compensations, rely on generating complementary income through service provision and refurbishment-related activities to sustain their operations. In any case, in all of them, local public policies and public policymakers play a role in encouraging cooperation and formal alliances among ecosystems and establishing service networks to ensure access to ICT devices.

The four ecosystems share a similar main goal and culture. This fact can be evidenced through the adoption of eReuse tools to support the operations of two ecosystems (item 9): eReuse and Nodo Tau. In the case of Ekoa, it uses GLPI, but it is adjusting the eReuse tools to its own reality, and thus to adopt the eReuse's accountability practices. Concerning Antel Integra, it uses GLPI and a platform developed in that ecosystem.

5.2 Governance of property rights in the explored ecosystems

Building on this characterisation, in this subsection we analyse the ecosystems considering their governance of property rights. Table 5 summarises the distribution of rights across the four ecosystems, while Table 6 introduces the participants in the exploration process, whose insights support the results of this analysis.

Overall, Ekoa and Antel Integra did not directly adopt the eReuse property-rights model; rather, their governance patterns substantive converged with those of eReuse. In contrast, Nodo Tau explicitly adapted the eReuse model to fit its local reality. This adaptation is particularly evident in the way that Digital Communities are supported through community infrastructure and municipal collaboration. As noted by P2 (Coordinator of Digital Communities of Nodo Tau), "we leverage existing infrastructure in the marginalised neighbourhood to connect with vulnerable citizens through their trusted community centres. Since the municipality cannot directly purchase reused devices, it instead contracts services under which Nodo Tau equips and maintains digital classrooms, ensuring a viable, effective, and sustainable model. This service-based approach secures long-term access to refurbished ICT devices and embeds maintenance and support within community networks, fostering shared responsibility." Building on this service-based approach, P1 (Manager at Nodo Tau) indicates: "through subsequent projects, we were inspired by eReuse's agreements on property retention, servitisation models, and standardised agreements to strengthen our Digital Communities programme."

In what follows, we highlight both similarities and divergences, drawing on participant quotes to illustrate how property rights are enacted in practice.

5.2.1 Exclusion. In all four initiatives, donors preserve the *exclusion* right, deciding whether and under what conditions ICT devices leave their ownership, and determining how *access* and *withdrawal* right may be granted (item 10). Refurbishment centres and second-hand managers, beyond carrying out technical processes, are responsible for ensuring this donor commitment. However, the formality and responsibilities associated with this right vary.

Table 4. Characterization of the explored ICT reuse ecosystems.

Item	Aspect description	eReuse	Nodo Tau	Ekoa	Antel Integra
1	*Operational start year*	2015	2019	2009	2011
2	*Leadership*	Pangea and Technical University of Catalonia.	Nodo Tau association.	Universidad Nacional de La Plata (UNLP).	Antel (Uruguayan telecom).
3	*Location*	Catalunya, Madrid (Spain).	Rosario (Argentina).	La Plata (Argentina).	Montevideo (Uruguay).
4	*Resource dependency*	Devices donated by public organisations to the second-hand ICT manager.	Devices donated or disposed of by public or private organisations to Nodotau.	Devices ceded by organisations and individuals to Ekoa.	Devices donated by organisations and individuals to Antel.
5	*National ecosystem (2022 [28])*	EPR systems enforced.	No EPR.	No EPR.	Emerging EPR.
6	*Economic aspects*	Devices are ceded to intermediary organisations that cover circularity costs.	Revenue generated through second-hand sales and agreements with the Municipality of Rosario for service provision.	Funded by UNLP with occasional external support. Devices are ceded in two ways: (i) via use cession to non-profits and public interest organisations; (ii) under chain-of-custody for internal university use.	Funded by Antel. Devices are donated at no cost through agreements with national social agencies acting as coordinators.
7	*Policy Making*	Supported by Barcelona Council, Waste Agency of Catalonia, and EU projects.	The municipality of Rosario maintains agreements with Nodo Tau to equip and maintain digital classrooms using existing infrastructure in underserved neighbourhoods, within the framework of the Digital Communities programme.	Supported by the UNLP and recognised as pilot plant by ITU (certified reuse manager in 2022); it trains urban recycler cooperatives in decentralised e-waste strategies.	Managed by Antel, supports over 270 community centres with free networking equipment and maintains Uruguay's digital inclusion networks through public inter-agency cooperation.
8	*Interaction with resources*	Preventive maintenance (servitised models).	Corrective maintenance for Digital Communities.	Corrective maintenance for some programmes.	Preventive/corrective maintenance depending on the programme; phone help line.
9	*Supporting software used*	eReuse tools.	eReuse tools.	GLPI; adapting eReuse tools.	GLPI + Antel software.

In eReuse, donors sign formal agreements that require traceability and accountability, ensuring that every role exercising property rights over a device is documented in accordance with ecosystem rules. The Workbench and Devicehub system jointly operationalise these tasks.

In Ekoa, as P5 (Manager) notes: "large donors like the World Bank expect sustainability reports in return for ICT donations, which reinforces the need for accountability mechanisms." This external pressure has pushed Ekoa to adopt eReuse reporting tools, even without the same traceability obligations as eReuse. This adoption, however, needs contextualisation, as echoed by P6 (Leader of software development in Ekoa), who explains: "adapting eReuse tools to our local procedures has been key to aligning the software with how we manage device reuse in our context. It's not just about adopting a tool but also customising it to reflect our community's workflows and impact reporting needs." This included deploying the systems on internal servers to retain control of data.

In Nodo Tau, accountability is optional and traceability is not a formal obligation. Nevertheless, their collaboration with eReuse has provided opportunities to adapt existing tools to their own operational needs. As noted by P1 (Manager): "our collaboration with eReuse began with adapting their Workbench and DeviceHub tools for device accountability to our local context, including

Table 5. Property rights in the explored ICT reuse ecosystems.

ID	Aspect description	eReuse	Nodo Tau	Ekoa	Antel Integra
10	*Exclusion right*	Retained by donors; formal agreements require traceability and accountability.	Retained by donors; traceability and accounting are rarely required, but are optionally provided.	Retained by donors; accountability expected by major donors.	Retained by donors; accountability expected and traceability used to support intermediary organisations.
11	*Access right*	Sequential transfer: second-hand ICT managers and/or refurbishment centres to intermediary organisations, and to end users.	Sequential transfer: refurbishment centre to intermediary organisations and to end users.	Same as Nodo Tau.	Sequential transfer: refurbishment centre to intermediary organisations (sometimes via higher-tier bodies) and to end users.
12	*Withdrawal right*	Sequential transfer: refurbishment centres to intermediary organisations under use of cession.	Sequential transfer: refurbishment centre to self-managed community centres in the Digital Communities programme under use of cession.	Sequential transfer: refurbishment centre to intermediary organisations under use of cession.	Refurbishment centre transfer full right to intermediary organisations.
13	*Management right*	Initially exercised by refurbishment centres and second-hand ICT managers; partially transferred to both distributors, for allocation, and maintainers.	Initially exercised by refurbishment centre, allocation partially transferred to the Rosario municipality. Refurbishment centre and community centres maintain.	Refurbishment centre and UNLP responsible for allocation, while maintenance is limited to a single programme.	Refurbishment centre and higher-tier bodies allocate. Refurbishment centre maintain (two-year guarantees and postal repair logistics): devices are renewed after the guarantee expires, enabling continuity of service.
14	*Alienation right*	Held by second-hand ICT managers and/or refurbishment centres; devices can be resold.	Held by refurbishment centres; devices can be resold.	Held by refurbishment centre; devices cannot be resold.	Transferred to intermediary organisations; devices cannot be resold.

Table 6. Interviewed participants and their roles in the ICT reuse ecosystems.

ID	ICT reuse ecosystem	Roles
P1	Nodo Tau	Manager
P2	Nodo Tau	Coordinator of Digital Communities, Municipality of Rosario
P3	Nodo Tau	Coordinator of Olavarría community centre
P4	Nodo Tau	ICT agent at Virtual Sum
P5	Ekoa	Manager
P6	Ekoa	Leader of software development
P7	Antel Integra	Manager

joint developments such as linking DeviceHub with a business management system to integrate refurbishment workflows with invoicing." This illustrates how, even without mandatory accountability frameworks, Nodo Tau has selectively incorporated eReuse tools to enhance the exercise of property rights over devices.

In Antel Integra, there have not yet been formal collaboration with eReuse. Currently, they employ their own systems to ensure accountability prior to allocation. As highlighted by P7 (Manager): "before the allocation, each device is traced in our system to ensure accountability and the intermediary organisations' support." In this case, traceability serves as a formalised property

rights mechanism, and as a practical tool to guarantee that refurbished devices are fully operational and supported when reaching intermediary organisations.

5.2.2 Access. In the four ecosystems, the *access* right follow a sequential transfer model (item 11). Devices typically pass from refurbishment centres or second-hand managers to intermediary organisations and to end-users. The main divergence is observed in Antel Integra, where an additional higher-tier body may coordinate distribution before devices reach intermediary organisations.

5.2.3 Withdrawal. Across initiatives, the *withdrawal* right is not retained by refurbishment centres but delegated to other actors. In eReuse, Ekoa and Nodotau this right is transferred to intermediary organisations under use cessions (item 12). For example, in Olavarría (one of the Digital Community of Nodo Tau), the community centre acts as the intermediary organisation, providing the physical infrastructure that enabled digital classrooms. As P3 (Coordinator of Olavarría community centre) highlights, "in our neighbourhood of 40,000 people, COVID-19 led to a 70% dropout rate among school-age children. Fortunately, the new digital classroom allowed us to run employability workshops and support youth in finishing secondary education."

Antel Integra differs by transferring the *withdrawal* right to intermediary organisations through full property right transfer, rather than through use cessions as in the other ecosystems.

5.2.4 Management. The governance of the *management* right is exercised differently across the ecosystems, with vary scope and density of actors. eReuse initiative shows a higher density and diversity of actor roles in distribution and maintenance (item 13). However, in the other ecosystems the roles of distributor and maintainer are primally exercised by the refurbishment centres themselves, sometimes complemented by municipalities, universities, community organisations and higher-tier bodies, but without the same level of actor diversification as in eReuse.

The exercise of the *management* right involves three key functional roles that shape how reuse ecosystems operate: distributors, maintainers, and ICT agents. First, distributors ensure that devices are allocated and well-matched. Having an explicit distributor role allows ecosystems to empower other local actors, tailoring allocation to community needs and aligning reuse with broader digital inclusion objectives.

Second, maintainers play a key role in mitigating the perceived risks associated with reuse devices, given the refurbishment centres cannot provide warranties equivalent to those offered by original manufacturers. Instead, trust is built through service continuity, proximity, and capacity building initiatives. As P1 (Manager of Nodo Tau) explains, "technical training activities are carried out for Digital Communities in the repair and management of ICT devices". These localised support mechanisms enhance functionality but also help mitigate rebound effects, i.e., the risk that second-hand ICT devices fail to substitute for new purchases if they are poorly maintained or mismatched to users' needs.

Third, ICT agents extend the *management* right to belong allocation and maintenance, as meaningful connectivity also requires digital literacy and close support. As P4 (ICT agent at Virtual Sum - Nodo Tau) explains: "we welcome between 30 and 50 people every day. This neighbourhood faces a double vulnerability, as many residents are from the discriminated *Quechua* and *Qom* communities. I teach them how to create basic documents, open an email account, and manage online administrative procedures. With these skills, they can use the ICT devices we provide them."

5.2.5 Alienation. Once donor rights are transferred, excluding the *exclusion* right, refurbishment centres or second-hand managers in eReuse hold the remaining rights (item 14). As noted in items 11-13, these are subsequently transferred to other actors, while alienation remains with the centres (except in Antel Integra). Alienation entitles them to decide the final destination of the device,

including recycling, when it is no longer suitable for reuse, or resale to the general public (only in eReuse and Nodoatau, and only if donor explicitly transfers the *exclusion* right).

6 Discussion

Building on the proposed governance model, and considering the explored ICT reuse ecosystems, this discussion connects the design decisions made for the eReuse model, with key theoretical debates and practical challenges related to the CE and ICT reuse. This discussion is organised into five major themes: (i) private goods, (ii) redefinition of the commons through the bundle of rights, (iii) governance based on CPR, (iv) the role of supporting tools as enablers for managing the property rights, and (v) the ongoing challenges for consolidating commons within the CE framework. Finally, we present the limitations of this work.

6.1 Private goods: a second chance through coordinated donations

In traditional frameworks, where ICT devices are considered private goods [47], both accounting and software obsolescence accelerate the disposal of devices that are still functional [27, 39, 67]. In that sense, the results presented in Section 4.2 indicate that many devices processed by eReuse were discarded after amortisation, despite showing no hardware failures.

However, the evidence also shows that nearly half of the devices can have a second life when public and private organisations choose coordinated donation channels, like in eReuse where 45.9% of traced devices were successfully refurbished and redistributed. In that process, e-waste is reduced, traceability is strengthened, and social, economic, and environmental value is integrated rather than treated as separate outcomes. Previous studies have typically addressed these impacts in a fragmented way, focusing separately on social impact [69], economic benefits [56], or environmental sustainability [3, 34]. However, this work shows that the impact of ICT reuse initiatives should be addressed in a more comprehensive way, opening thus several opportunities to rethink property rights and governance models.

6.2 Common goods: redefining exclusivity through the bundle of rights

The shift towards collective reuse of ICT devices requires a redefinition of the concept of property. Rather than viewing it as a single and indivisible right, the proposed model adopts the bundle of rights perspective [59], which allows property to be broken down into rights (particularly, *exclusion*, *access*, *withdrawal*, *management*, and *alienation*), and redistributed among different actors in the ecosystem. This distribution is based on explicit, formal agreements that assign responsibilities and decision-making capacities to the rights holders.

Unlike traditional models, where property is transferred linearly from one actor to another through successive and fragmented transactions, the proposed model is based on interdependent relationships among ecosystem actors. This configuration enables collective action to generate common goods that, while still rivalrous, are less underutilised and exclusionary; i.e., people can access a device as long as it is facilitated by an NGO, a community centre, or an inclusion initiative.

This shift from linear transfer to shared governance has been tested in practice in eReuse, and it inspired Nodo Tau to adopt similar cession agreements in its Digital Communities programme. Although not directly replicated, in Ekoa and Antel Integra property rights also appear fragmented across actors, showing convergent practices.

Property can only be exercised if the good is valued. In the linear paradigm, devices are typically discarded not because their real technical lifespan has ended, but due to subjective decisions such accounting rules. In contrast, circular models seek to preserve their value through rules that promote reuse. Yet, if these rules fail to clearly distinguish between what is reusable and what should be recycled, the ecosystem becomes overloaded. In this context, the “tragedy” is no longer

overexploitation, as expected according to [45], but rather the intake and processing of devices with no real potential for reuse, as occurred in eReuse with some public donations.

Without clear entry criteria, the system incurs costs of processing ICT devices that will not be redistributed, compromising sustainability. In that sense, limiting donations based on a specific computational capacity, along with restricting donations from private and public organisations, is a pattern observed and validated in other initiatives, such as Allemaal-digitaal [1], Digital Inclusion in Luxembourg [16], Nasco [41] and Computer Aid [13], which were consulted for validation during this work.

6.3 The CPR perspective in reuse goods and services

More than a simple redistribution of rights, the proposed model aligns with the logic of CPR systems as defined in [45], where sustainability depends on shared rules and adaptive governance. The common aspects are based not only on access, but also on the collective capacity to make decisions about the life cycle of the device. This logic enables key dilemmas to be addressed, such as whether to reuse or recycle, how access is defined, how to ensure hardware–software compatibility, and how to promote practices that avoid rebound effects. Managed at a local level, these challenges can be tackled more effectively than in extended production chains, thanks to the capacity for experimentation, iteration, and context-specific rule adjustment. Continuous self-evaluation and testing of alternatives are essential to sustaining these ecosystems.

As with natural commons that depend on resources, such as water or wood, the proposed model illustrates that in a CE, the physical object becomes less central, with its value increasingly derived from the ecosystem of collective practices, norms, and values that sustain its reuse and extend its life cycle. This perspective aligns with both emerging forms of cooperation within the framework of the CE [10, 49] and the potential of property rights to design interdependent spaces in industrial ecosystems [62]. In that sense, this work provides empirical evidence in response to calls from [63] to further validate the bundle of rights theory that, while promising, still requires more robust empirical grounding.

6.4 Software as enabler of property rights

Beyond traceability, the digital support for the activities considered in the proposed model allows ICT reuse ecosystems to exercise the property rights involving the actors. Open-source software tools, such as Workbench and DeviceHub, ensure the rights over *access*, *withdrawal*, *management*, and *alienation* are traced. Their adoption and adaptation by Nodo Tau and Ekoa illustrate how open-source software can facilitate decentralised cooperation without imposing a single model and enable cross-learning. In this sense, the software becomes a vehicle for operationalising property rights.

6.5 Challenges for commons in a circular economy of ICT devices

Despite the potential of commons-based and CE models, structural challenges persist. As noted by [49], these models face limitations such as the lack of comprehensive resource data, difficulties in scaling without losing local coherence, and governance gaps. The eReuse approach tackles these challenges by combining digitalisation of activities, which enhances traceability, actor coordination, and operational efficiency, with a redesign of property rights. These rights are understood as a lever for change that enables the distribution of responsibilities and facilitates interdependent agreements.

Another significant challenge is software-induced obsolescence, as noted by [27] and [39], which limits the use of functional devices due to incompatibility with proprietary systems. The four cases analysed in this work employ open-source software to extend device lifespans, although its adoption

remains limited. Overcoming this issue requires technical solutions and cultural adaptations, such as enhanced training, greater trust in open environments, and a shift towards digital sobriety practices [36, 58]. Thus, the value of a device is determined by its adequacy for real-world uses.

6.6 Model suitability

The property rights and governance model were evaluated as instruments to support ICT reuse activities in Latin American, where ICT reuse ecosystems and their actors share similar values, motivations, expectations, and goals regarding the reuse of ICT devices. Regardless of the positive results, it is unclear whether the model and supporting infrastructure can be extrapolated to support ecosystems in other socio-economic and cultural scenarios. What is clear is that the approach used to manage the property rights (i.e., as a bundle of rights on common goods) makes it not attractive for ecosystems that manage devices as private goods. In this sense, we should reflect on alternative governance and business models, particularly to avoid framing reused devices as a solution only for unconnected communities, and instead explore community-based or collaborative approaches that normalise reuse across the wider population, such as Commown cooperative [12].

7 Conclusions

Managing ICT devices as private goods leads to limited access for those with fewer resources, premature recycling of still-functional equipment, e-waste, and negative environmental impacts. Through an action research process conducted over nine years in the eReuse ecosystem in Barcelona, Spain, we iteratively defined and refined the property rights and governance model reported in this article, with the support of members of the eReuse network. The proposed model describes how the eReuse ecosystem operates and offers a framework for diagnosing, comparing, and designing similar initiatives.

At the heart of this model is the refurbishment process, which enables functional devices to be recovered, traced, and redistributed through coordinated agreements between ecosystem actors. When individual property dissolves into an integrated set of rights, the bundle of rights, a substantial change is effected in their nature, transforming them into common goods managed collectively. This results in greater access to ICT devices for those with fewer resources, an extension of the lifecycle of still-functional computers, and a reduction in the environmental impacts associated with premature recycling and generation of e-waste.

The suitability of the model to inform the design of other property rights governance models was evaluated in three ICT reuse ecosystems. Particularly, two in Argentina and one in Uruguay due to their sharing cultural affinities with Spain. The evaluation results indicate that the proposed model largely matches with the models used by the explored ecosystems. In case of differences, the proposals of the eReuse model tended to prevail over the ones from the explored initiatives. According to the opinion of the participants in the evaluation process, the major components of the model and its supporting tools seem to be appropriate to support their ICT reuse ecosystems. This shows the potential of the proposed model to inform the design of property rights governance models in contexts culturally similar to eReuse.

The future work in this research initiative considers analysing how the lessons learned from other ecosystems can help improve the proposed model, making it more flexible and robust. In this sense, experimentation in diverse contexts offers a rich opportunity for further research and improvements to this proposal.

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A Appendix

This appendix includes supplementary information about the organizations that participated in the several action research cycles and therefore contributed to defining and validating the proposed governance model.

Table 7. Organisations that participated in the action research process in eReuse, classified by actor type.

Actor category	# orgs	Nature of engagement
Policymakers	5	**eReuse**: Long-term collaboration: policy co-design projects with Barcelona City Council (multiple departments) and the Catalan Waste Agency [22]. **Latin American initiatives**: Coordinator of Digital Communities, Municipality of Rosario (Nodo Tau); Representative of the Provincial Agency for Social and Urban Integration (Ekoa); Antel technical leader (Antel Integra).
Donor organisations	38	**eReuse**: Ad-hoc donation agreements; supporting documents (inventories, receipts, accountability reports)†.
Refurbishment centres	10	**eReuse**: Long-term collaboration: reception notes and compliance reports with Solidança, Andròmines, Trinijove, Alencop, Fundación Esplai, AVV Meridiana, and ReutilizaK. **Latin American initiatives**: Nodo Tau, Ekoa, and Antel Integra.
Distribution organisations	3	**eReuse**: Long-term collaboration with Donalo.org, Banc de Recursos (both of which also act as refurbishers), and Circula.cat, documented through invoices.
Maintainers	3	**eReuse**: Medium-term collaboration documented through maintenance agreements and internal reports (Gatxan); consultations with Maadix and IsardVDI.
Intermediary organisations	100	**eReuse**: One-off device-transfer agreements†. **Latin American initiatives**: Olavarría, Virtual Sum and Mujeres Plaza community centres.
Recyclers	1	**eReuse**: Occasional consultations, end-of-life validation, and referral of non-reusable ICT devices from refurbishment centres lacking waste-management authorisation to certified recyclers (ACS Recycling).

† Donor organisation names withheld for confidentiality.

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