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Sustainability Assessment of Medicines Reverse Logistics in Brazil: Outcomes from the National and Local Systems

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Abstract: Brazil adopted a national medicines reverse logistic system (MRLS) in 2020 to properly discharge medicines for human use. Parallel to this, there are Brazilian municipal MRLSs that have been working since 2002 that facilitate the appropriate discharge or reuse of medicines. These systems are not linked with each other. This paper evaluates the national and the municipal Brazilian MRLS, and compares them regarding their principles, concepts, procedures, and (socio)economic outcomes using a modified sustainability assessment framework. It was found that shared responsibility is a principle of both MRLSs, but that local systems provide additional community benefits and lead to greater circularity in the use of medicines. Procedural aspects are highly formalized only in the national MRLS. The national MRLS collected and destroyed 52.7 tons of medicines in 2021 but did not disclose the costs. Estimations based on demographic data, information disclosed by one municipality, and secondary data from five other local systems indicate that the six municipalities could return around USD 123 million in 2021 to the benefit of the local population, if they spent USD 12.6 million on correct disposal. Such an estimate, however, is not fully trackable, and it exposes the lack of transparency and data collection at the local level.

Keywords: medicines reverse logistic systems (MRLS); Brazilian medicine returns; RLS sustainability assessment

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1. Introduction

Medicines reverse logistics systems (MRLS), although widely studied [1–7], are focused mainly on conventional pharmaceutical supply chains, highlighting competitiveness aspects related to wastage avoidance [1–3]. Recently, public–private issues, such as donations and possible recirculation [4], including reassignment between public health utilities, in [5] have been screened in this research field. Improvements in MRLSs involving a wide range of stakeholders [6,7], and efforts to calculate the financial value of generated waste are also targets of investigation [8,9], although with limitations related to specific legal regulations and scales. With the supply chain disruptions triggered by diverse causes, such as high costs to final consumers and to government procurement [4], scholars have resurrected the debate on medicine returns not only for proper disposal (in the case of a damaged or expired product), but for possible reuse [10–16], regardless of the traditional argument about the likely risks entailed in a further harnessing of these products [6,11,12,15].

Brazil is one of the countries in which MRLSs are most studied [4–6], and in which the investigations keep showing recurring problems such as poor management, poor collaboration, political interference, and financial and economic constraints, amongst others [5,17,18]. Nonetheless, to the extent of our knowledge, there are no studies examining both national and local MRLSs in Brazil. This situation has arisen because local systems that facilitate medicine reuse have been historically understood as informal activities, which makes research into the medicines reverse logistics (MRL) problematic [13,14]. Taking such a research gap into consideration, this study proposes the assessment of the outcomes of the recently implemented Brazilian MRLSs in 21 state capitals and in cities with 500,000 or more residents that take part in the official MRLS. It also proposes to assess the results of six local MRLSs—of which one, in Rio Grande do Sul State, provided full data about the collected, redispensed and disposed medicines—thus it was taken as a benchmark case for these informal MRLSs. A further five local MRLSs were from São Paulo (2) and Santa Catarina (3) States; these were selected because secondary information on the number of beneficiaries and persons that received returned medicines are disclosed in the official websites of their city halls, or can be found in local academic publications, but none of them provided structured data on MRL. Each of these municipalities, except one from Sao Paulo, had fewer than 370,000 residents in 2021.

The local MRLSs are embedded but not accounted for within the national system, and they are widely known as solidary pharmacies. A better understanding of the routines of both systems (national and local) that run in parallel, but remain disconnected from each other, is necessary to unveil the full potential of MRLSs in Brazil. The main questions posed are: what are the outcomes of the national and the municipal MRLSs in Brazil? And what are the principles, concepts, procedures, and (socio)economic results of each system? Such questions address contributions that will enrich the discussion on medicine reuse in Brazil as part of a MRLS, assuming that this activity is a type of black box running in the daily activities of the health sector [14,19]. Although there is recent research comprehensively covering the consumers' impressions of medicine reuse, mainly in the UK [10,11,15,16], including the issues of packaging [20] and technological traceability [18], gaps remain on the description and assessment of the simultaneous routes that left over medications go through, with special focus on local scales [14]. It is assumed that the clarification of the informal features typical of the municipal MRLS can shed light on their approach to redispensation [19]. Parallel to this, the assessment of the formal activities that characterize the national MRLS [6,7] can bring contributions to improve sustainability in this field.

This research is therefore framed within the Brazilian national and municipal MRLSs with the aim of comparing them considering qualitative data and quantitative data for the year 2021. To achieve this goal, the study adopts the perspective of sustainability in Reverse Logistics (RL) and Sustainability Assessment (SA) adapted to MRLSs. It is developed in five main sections after this introduction. In the next section, a comprehensive literature review is offered covering the following topics: (i) RL principles, concepts, activities, and sustainable performance; (ii) a brief description of the traditional SA framework [21–23] from the perspective of impact assessment applied to public policies (i.e., the case for both types of MRLSs investigated) and the approach for applying SA to RL; (iii) a description of the main principles, concepts, procedures, and transactive (socioeconomic/economic) aspects ingrained in the Brazilian federal decree and in the municipal law on medicine returns for human consumption. In the third section, the methodology—research design with procedures—is developed and described based on the literature review. The fourth section compares the two MRLSs in light of the evaluation framework. Final remarks, limitations and suggestions for further research are presented in the final section.

2. Literature Review

This section introduces the elements needed to build an operational framework in order to the describe the results of the Brazilian MRLSs through the perspective of SA. It is systematized into four subsections: a comprehensive description of studies on RL

principles, concepts, activities, and sustainable performance (Section 2.1); the presentation of the SA framework related to impact assessment of policies, plans, and projects, including those of the public sector (Section 2.2); a description of the principles, concepts, procedures, and transactions of the federal MRLS (Section 2.3); a description of the principles, concepts, procedures, and transactions of the municipal MRLS.

2.1. RL Principles, Concepts, and Sustainable Performance

Reverse Logistics (RL) is a widely researched theme. The majority of the studies in this field have been focused on understanding the factors that drive and constrain the reverse flows, and the optimization of reverse operations' efficiencies in supply chains [1–3]. Recently, approaches to RL have focused on the possibilities of circularity in the return of products and/or parts of products in diverse types of business sectors [24,25] including electronics [26–28], clothing [29,30], domestic solid wastes [31,32], packaging [33,34], and medicines [4,17,35–37], amongst others. The main principles of RL have recently been clearly aligned with circular economy thinking that stimulates awareness of the supply chain stakeholders and the advantages of avoiding, reducing, reusing, refurbishing, and sharing products, and, where possible, optimizing the design stage of developing goods to facilitate more circularity during the use stage [25,38].

In simple terms, RL is the movement of goods, or their parts, in the opposite direction to the traditional routes through which value is created in typical businesses [38]. In more detail, in [27] we can consider RL as the activities of planning, executing, and monitoring the flows of materials and associated information from the end-of-use stage, aiming at recapturing the value of products (closed loops), or from the end-of-life stage (linear routes), with the aim of correct disposal. According to [39], RL also refers to the investigation of a product's condition by sorting and classifying it before making a decision on further use. The actions of businesses or public agents to resell, reuse, recycle, and sustainable dispose are also considered to be part of RL [35]. Scholars associate RL with environmentally friendly operations [32] and corporate social responsibility [40], indicating consequent socioeconomic or economic benefits such as the possibility of repair, reselling with discounts, and donations [25]. With respect to the routines, RL involves take back, returns of goods and/or its parts, sorting, inspection, storage, transportation, and monitoring and reporting of the physical and respective monetary quantities that return [32,41].

Shared responsibility [27,33] implies the ethical principle of all RL stakeholders to harness as much value as possible from each product, including in their return to a new consumption cycle. Another of RL's pivotal principles is the hierarchy of priorities in which avoiding waste is the top priority, followed by reuse [35,42].

Sustainability targets are common in RL studies because the reverse flows unavoidably seek balanced economic, ecological, and/or social outcomes; although, in the majority of cases these achievements are not simultaneously fulfilled. Given this difficulty, the links between sustainability and RL are not always explicit. Hard to control aspects, such as consumer behavior (willingness to take returned goods, willingness to pay for the returns) [43], and collaboration between stakeholders, co-exist with other aspects, such as product value, costs of RL, and the quantity and quality of returned goods, that complicate the sustainable materiality of RL [24].

Recent research highlights that medicine reuse can be framed under the lenses of circular and sharing economies [14], although circularity is still far from reality in the MRLSs. Medicine sharing receives little attention in the academic literature [15,16]; although, a tendency to rethink this issue has been gradually detected in recent years, giving the consumers opportunities to express their opinions and needs [11,17,18]. Consumers have a decisive role in boosting circularity and sharing. Beliefs and recognition of the need for returns as a common societal value are more critical than statements from consumers that they intend to make the returns [36]. Such understanding is reinforced by the existence of adequate and well-placed disposal collection points and objective orientation on delivery through campaigns [7,28]. Thus, social aspects from consumers' initiatives, and addressed

to possible beneficiaries, demand urgent research, regardless of being historically dismissed in RL sustainability studies [44]. Another sensitive point is the lack of standardized indicators to monitor collection, storage, transport, reuse, recycling, and final disposal even in the same supply chain [40,42].

In MRLSs, the need to fulfil ecological sustainability principles is justified by the hazardous effects of careless discharge of pharmaceutical products on surface waters and groundwaters [45–50]. Diverse technological solutions were proposed to curb these pollutant sources from the pharmaceutical industry's wastewater [51–58]. Nevertheless, their disposal in the environment remains poorly regulated [31], and the majority of the population is not aware of the persistence of the pharmaceutical products in water [31,33].

2.2. Traditional Sustainability Assessment (SA) and Hurdles to Reverse Logistics SA

Sustainability Assessment (SA) is a set of processes intended to support decision making for policies, plans, programs, and projects respecting the principles and practices of environmental, social, and economic sustainability [21–23]. It was originally developed to address the needs of impact assessment and can be adapted to specific public policies—such as RL—because it entails pluralism (diversity of context) and continuous learning [21]. The main dimensions of SA are substantive, normative, procedural, and transactive.

The substantive dimension of SA refers to the capacity of the assessment to provide informed decisions based on strong conceptual references, as principles, concepts, and arguments [22]. The normative dimension is represented by the norms that rule the assessment [22]. The procedural dimension indicates the steps to be followed to accomplish sustainable goals, which must be made explicit [22] and traceable. The transactive dimension aims to assess the efficiency (timeliness and costs) [22]. According to [23], clear representation of the sustainability attributes of a policy is very complex, and SA helps to organize this task, highlighting the processes, the procedures, and the norms, and how they are articulated.

The usefulness of SA for RL assessment is dependent on the agreement of clear substantive, normative, procedural, and transactive aspects, and the majority of the RL systems lack measurement tools that can be traceable and monitored in the long term [25]. In fact, sustainability RL measurements are usually applied to the level of industrial or other business units or to a small group of units rather than to the level of complex supply chains [59] as are found in the pharmaceutical industry.

The current methods for managing and measuring sustainability RL performance in supply chains are incomplete, thus, scholars combine them using a diversity of quantitative procedures—usually multicriteria decision making with fuzzy tools [60], and business management tools such as Balanced Score Card (BSC) with large scale traditional sustainability indicators such as those of the Global Reporting Initiative (GRI) [61]. This results in assessments that jeopardize comparisons because of the complexity of the supply chain networks, the limited amount of data available, and problems of scalability and standardization [62]. Given these difficulties, the adaption of the traditional SA to specific RLs can be an alternative to the Brazilian MRLSs SA. The core driver to structure the adaptation of SA to MRLSs is the normative dimension (decree, law) because it contains principles, concepts, procedures, and some transactive directions for the MRLSs.

2.3. Principles, Concepts, Procedures, and Transactions of the Federal Brazilian MRLS

The Brazilian federal MRLS is ruled by Decree 10,388 [63], that is its normative dimension. This decree implemented the formal, national MRLS in the country in 2020, in 21 state capitals and in municipalities above 500,000 residents. The local, municipal MRLS is ruled by several municipal laws that in general keep a similar structure and content. In this research, the solidary pharmacy law of the municipality from Rio Grande do Sul State, is adopted as the normative reference because this law was used as a model by solidary pharmacies in 46 municipalities.

From the federal decree, the following contents are highlighted as part of the substantive dimension:

- Principles: (i) social control of the society with respect to mechanisms of medicine returns; (ii) shared responsibility amongst all stakeholders—from industry, distribution, importation, retail, and consumption—through the whole life cycle of the returned goods; (iii) sectoral agreement as a contract between the stakeholders involved in medicine production to assure shared responsibility fulfillment.
- Concepts: (i) RL as a tool for socioeconomic development; (ii) primary storage: storage of returned medicines by the retailers; (iii) secondary storage: storage of returned medicines by the distributors, before transportation to final disposal; (iv) collection campaign: punctual actions, at retail collection points of returned medicines, in cities with number of residents above 500,000, in the first phase (up to September 2023); (v) legal representative: institutions that legally represent the production sector involved in the MRLS; (vi) manager representative: institution in charge of structuring, implementing, and monitoring the MRLS, hired by the production sector.

Regarding the procedural dimension of the federal MRLS, the production stakeholders must: (i) create a Performance and Monitoring Group (PMG) for the system follow up, including the elaboration of a yearly report collating data about the outcomes of the system that must be delivered to the Brazilian Environmental Ministry; (ii) provide training to the third party or manager representatives to enable them to carry out reverse flows routines; (iii) the consumers must deliver the unused or expired medicines to the drugstores; (iv) the retailers and the distributors must report the quantities stored in primary and secondary storage, respectively.

The transactive dimension comprises obligations including: (i) the retail managers must buy and install standardized collectors for the use of consumers in the drugstores, and leave available space for primary storage; (ii) the distributors must buy standardized packages to protect the returned medicines, and store them in secondary storage places; (iii) all the stakeholders, except consumers, must pay for the transportation of the returned medicines to the producers; (iv) the industry and the importers must pay for the correct disposal of the returned medicines.

2.4. Principles, Concepts, Procedures and Transactions of the Municipal MRLS

The main substantive aspects of the municipal MRLS are the principles of complementarity with respect to the federal MRLS. The municipal normative recommends that the Brazilian Policy of Solid Wastes Management should be followed [64], and reinforces the shared responsibility of all stakeholders for the returns. The municipal MRLS does not offer strict concepts. Rather, it states as its objectives the collection from diverse sources, re-harnessing, redispensation to the population, and exchange/reassingnment of medicines with public or private institutions.

The procedural dimension of the solidary pharmacies, according to the law, includes: (i) to receive, sort, and evaluate the quality of received medicines, check out the expiry term and physical integrity of the product, its packaging and the medicine leaflet; (ii) to redispense; (iii) to provide pharmaceutical guidance for correct medicine use; (iv) to provide collection programs; (v) to implement records of received, stored, redispensed, and discharged quantities of medicines; (vi) to prepare inventories and reports of the amounts received, stored, redispensed, and discharged. All such procedures are the responsibility of the pharmacists of the solidary pharmacies.

In the transactive dimension, there is the obligation of the municipality to pay the costs of correct disposal of leftover medicines not considered viable for a new cycle of consumption, and of the expired products. The benefited persons must be over 18 years old, provide identification, a medical prescription, and proof of residence in the municipality and of an individual income of 1.5× the minimum Brazilian wage.

3. Methods: Research Design and Procedures

MRL research, as a field related to the pursuit of sustainability and as a part of an interdisciplinary and complex subject, can be carried out through diverse methods. This study adopted a mixed qualitative and quantitative [65] approach, founded in the revised literature on RL concepts and principles [66], sustainability in RL, SA, and SA in MRL. Through the literature review, it was possible to adapt the traditional SA framework to a specific MRLS framework (Figure 1). Tables 1 and 2 summarize the SA dimensions and aspects/procedures in the federal and municipal MRLSs, respectively, from the normative directions. The procedures were divided into theoretical steps (Tables 1 and 2), already explained, in field and documentary research, and in experimental estimation.

Table 1. SA dimensions in federal Brazilian MRLS.

Dimension	Aspects/Procedures	Who Would Care
Substantive	social control	consumers
	shared responsibility	all stakeholders
	sectorial agreement	all stakeholders but consumers
	RL as a tool for socioeconomic development	all stakeholders
	primary storage	retailers
	secondary storage	distributors
	collect campaign	retailers
	legal representative	third party
	manager representative	third party
Procedural	create PMG	all stakeholders
	training	all stakeholders
	deliver medicines	consumers
	report quantities	retailers and distributors
Transactive	buy and install collectors	retailers
	buy and install packages	distributors
	pay for transportation	all stakeholders
	pay for disposal	industry and importers

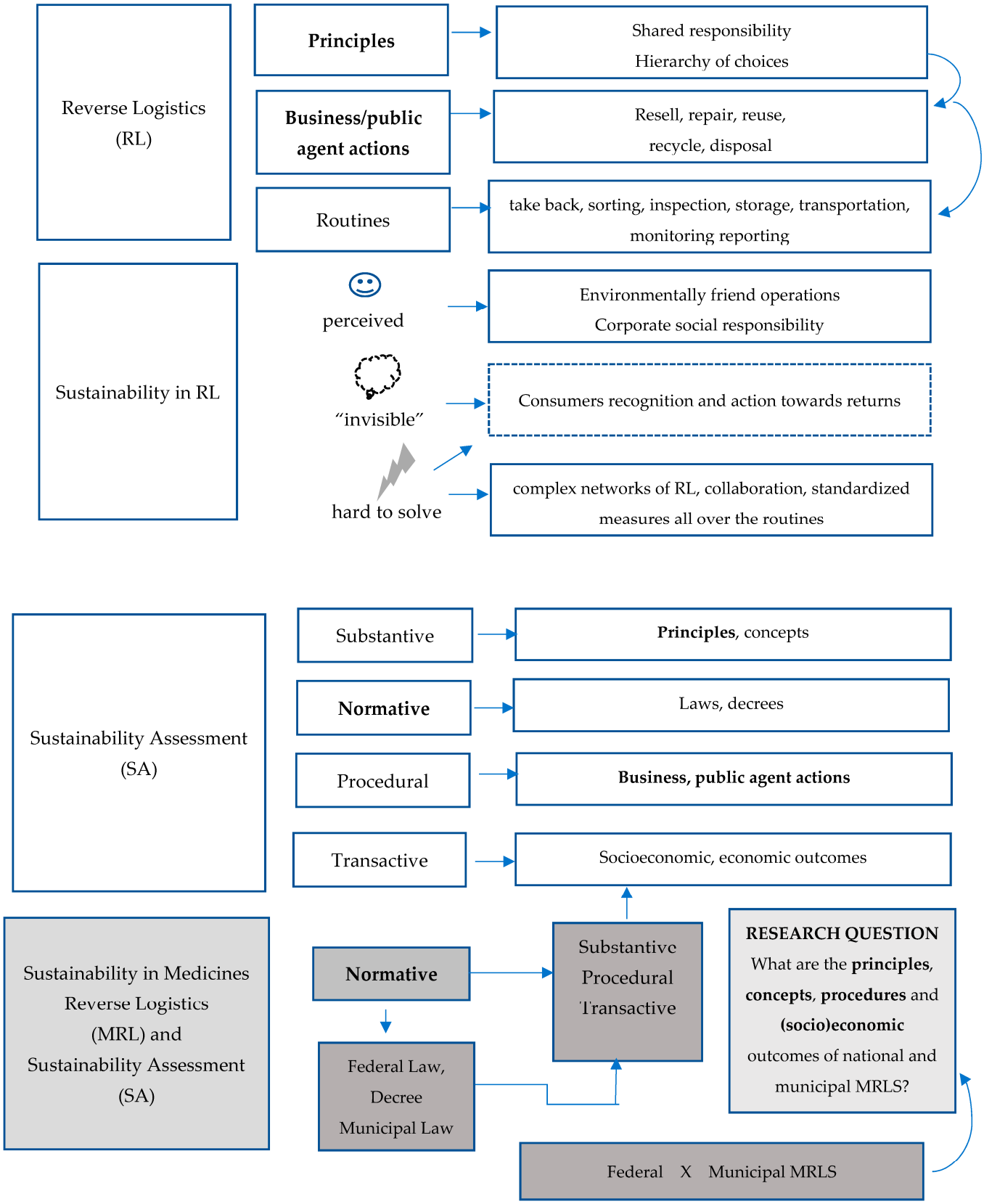

Figure 1. From RL and sustainability in RL to SA and MRLS SA.

Table 2. SA dimensions in municipal Brazilian MRLS.

Dimension	Aspects/Procedures	Who Care
Substantive	complementarity to governmental pharmaceutical assistance	pharmacists
	partnerships	
	guidance by Brazilian Solid Wastes Management	
Procedural	receive medicines	pharmacists
	assess medicine quality	
	sort medicines	
	storage medicines	
	redispense medicines	
	create and keep records on quantities	
	provide proper discharge	
Transactive	pay for the correct discharge	municipal public authority
	18-years-old age	beneficiaries
	identity document	
	medical prescription	
	residence comprovant	
	income comprovant	

3.1. Field Interviews and Documentary Research

Fieldwork was undertaken from August 2021 to December 2022, in two steps: first, invitations for interviews and questions on the MRLS's performance were sent to representatives of the federal and the municipal MRLSs, using phone and e-mail; second, documentary research was undertaken to obtain structured and unstructured data on MRLS performance. The aim was to ascertain the physical and monetary quantities collected, redispensed (in the local systems), and discharged, and the main barriers for the system management.

From the national MRLS, only the Union of Pharmaceutical Industry (Sindifar), in Rio Grande do Sul State, participated, sending incomplete answers and no data. Structured and normalized data on the performance of the federal MRLS, only on physical collected quantities in 21 capitals and cities above 500,000 residents, were found on the website of the RLS manager [67]. From the municipal solidary pharmacies, of 28 invited that already had programs running, from Rio Grande do Sul (22), Santa Catarina (3), and São Paulo (3) states, only one from Rio Grande do Sul sent full quantitative data of physical and monetary performance about medicines received, redispensed, and disposed of in the period of 2016–2022, and on the number of beneficiaries. Two pharmacists from the Rio Grande do Sul State gave an interview of 50 min each providing details about their routines in the solidary pharmacy. One pharmacy in Santa Catarina state provided incomplete data on the number of benefited persons by day in 2016. Secondary data on the number of benefited residents of two solidary pharmacies of São Paulo, and one of Santa Catarina were found on the websites of the respective city halls [68–70], and in regional academic literature [71].

3.2. Experimental Estimation

In an experimental step, the research advanced to estimate the likely performance of the MRLS of five solidary pharmacies from which unstructured data were obtained about the number of benefited persons. To normalize, all estimations were carried out for the year 2021, considering that the federal MRLS also provided records of this single year.

Firstly, the pharmacies were codified as RS A (the benchmark, of Rio Grande do Sul State); SP A and SP B (the solidary pharmacies of São Paulo); and SC A, SC B, and SC C (the solidary pharmacies of Santa Catarina). The RS A data were displayed in a spreadsheet. This spreadsheet was complemented with secondary demographic data obtained from the Brazilian Institute of Geography and Statistics (IBGE) on the population of RS A in 2021 and the number of residents with an average income of half of the minimum wage (considered needy persons) in the same year. The monetary data of RS A (on collected, redispensed, and discharged medicines) were converted into USD currency using the average exchange USD x Brazilian currency of 2021. It was possible to estimate the average value per capita that would be redispensed (considering the whole population, the population with a half of minimum Brazilian wage, and the population of persons that received the medicines). Calculations on the values of discharged medicines by RS A to the same types of populations (whole, needy, and actual beneficiaries) were also made using available data from 2021. Taking these as reference transactive outcomes, and having the demographic data of the other five solidary pharmacies (SP A, SP B, SC A, SC B, SC C) in the same year, as well as the number of residents with income of half of the minimum wage in each municipality (from IBGE data base) [72], an estimate was made of the values redispensed and discharged in these five municipal MRLS.

The estimation applied the principle of proportionality regarding the size of the population, having as a comparison base the RS A population in each considered year. All calculations followed this principle, which means that the per capita values that would be hypothetically redispensed to the whole population of each municipality would be the same. The differences appear regarding the per capita values that would be redispensed to the needy population (because the municipalities have different proportions of population with a half of minimum wage income).

The principle of proportionality was also employed to estimate the monetary costs of medicine discharges in each of the five "solidary pharmacies" with missing data, with respect to their whole population and their needy population (with income of half of the minimum wage). To calculate the respective outcomes in each municipality with respect the number of likely benefited persons (medicines redispensed and discharged in each solidary pharmacy), unstructured data were collected from secondary sources related to each of the five municipalities. Table 3 displays the original unstructured (intermediary) data obtained for SP A, SP B, SC A, SC B, and SC C, and details how these data were converted to reach the respective estimations in the format "benefited persons/year". Having these intermediary data, the proportionality principle could be employed to obtain the estimation of the monetary values per capita that would be addressed to the benefited individuals in redispensation and in discharge costs. In this case, it was assumed that the number of benefited persons in the five municipalities would be kept constant throughout the years but are portrayed only for 2021. The averages of all monetary values (collected, redispensed, discharged) were calculated. All these data and calculations are available in Supplementary Materials.

Table 3. Unstructured data on the number of beneficiary persons in five solidary pharmacies.

Solidary Pharmacy	Beneficiaries (Original Unstructured Data)	Data Transformation	Estimated Beneficiaries/Year (Considered Only 2021)	Source
SP A	584,354 in 20 years (2002–2022)	584,354/20 years	29,218	[73]
SP B	11,748 (July 2016–July 2018)	11,748/24 months = 489.5 489.5 × 12 months	5874	[74]
SC A	100/day (2016)	100 × 5 (working 5 days a week) = 500; 4 weeks in a month = 500 × 4 = 2000/month; 12 months in a year = 2000 × 12	24,000	Pharmacist
SC B	15,157 (2017)		15,157	[71]
SC C	11,000 (September 2017–September 2019)	11,000/24 months = 458.3 458.3 × 12 months	5500	[75]

4. Results and Discussion

The results are displayed according to the MRLS SA framework developed for the case of the federal and the municipal MRLSs. Substantive (Section 4.1), procedural (Section 4.2), and transactive outcomes and comparisons (Section 4.3) are shown and analyzed for each case, supported by interviewee responses—one representative of the federal MRLS, and two of the municipal MRLSs. In Section 4.4, the economic costs of the federal MRLS are shown, and insights provided of the experimental estimation on the performance of the municipal MRLS for the six solidary pharmacies selected in this study.

4.1. Substantive Comparative Assessment of the MRLS Outcomes

The common principle of RL between the federal and the municipal Brazilian MRLSs is the shared responsibility of all stakeholders for the medicine returns [27,28]. In the federal system it is mandatory through Decree 10,388 [63], but in the municipal system the pharmacists do not perceive the shared responsibility to be a reality because of the excessive workload associated with tasks related to the RL (as stated by two interviewees from RS A solidary pharmacy). According to the interviewees, lately, 60% of the collection has been unusable—which indicates a careless attitude from the community that donates and raises questions about the shared responsibility as a respected principle [27,31,33], mainly from the consumers' perspectives [43,44].

The sectoral agreement, another principle of the federal MRLS accompanied by targets for all stakeholders, including the consumers, is not being followed as consumers are barely participating through return of unused medicines [4,7,36]. Conversely, in the municipal MRLS, the equivalent principle is of the partnerships among the solidary pharmacies and the public and private agents mainly from the industrial and service sectors (distributors, laboratories, physicians), from the health system (basic units of health, hospitals), and from the educational system (universities). The sectoral agreement binds the stakeholders through objective goals to be jointly achieved and sets productivity performance targets for the stakeholders in a complex supply chain network [59,61], and the partnerships in the solidary pharmacies have been proved to be effective and flexible, enabling reassignment of potentially reused medicines from one basic health unit to another in the same region. According to the interviewed pharmacists, the system helps to avoid expiry of unused medicines and, therefore, further product wastage. Furthermore, it fulfills another principle of the municipal MRLS—the re-harnessing of goods.

In the federal MRLS, the principle of social control enables the citizens to participate in the public policy of medicine returns, although this participation is, in practice, limited to the delivery of used medicines. Even so, the population is not active, and has difficulty

understanding the harmful effects of medicine mismanagement on the environment [48,49]. Given the possibility of redispensation, in the municipal MRLS, there are delivery persons (donators) and receivers which portrays a synergistic role to the citizens as they can be beneficiaries and donators.

The legal concept of RL as a tool for socioeconomic development [63], although mandatory, is not fully applied in the federal MRLS, because it supposes that the reverse flows could bring more environmental benefits than from the incineration or correct disposal in landfills that prevents damage to the soil, surface waters and groundwaters [45–49]. Thus, circularity [13,38] is yet to be achieved in this system; although, in the municipal MRLS, closed loops [25] are observed since the needy persons have access to returned medicines [11,12,14,15].

The representative of Sindifar RS argued, in an interview, that the supply chain business stakeholders do not consider the possibility or re-harnessing the used, not-expired domestic medicines, even after technical inspection that can lead to the confirmation of the reuse possibility, because of health risks to the potential users [15,16]. Preventing such goods from being misused would satisfy the socioeconomic criteria, according to the business stakeholders. From the opposite perspective, the municipal MRLS embraces the possible health risk caused by the consumption of reused medicine, counter arguing that the risk of restricted access to medication due to economic poverty and its harmful consequences must be considered instead, and correct use is verified through the pharmaceutical assistance service and community campaigns [68–71].

Finally, with respect to collection campaigns as a principle of the federal MRLS, it is noteworthy that they are mainly delivered by the retailers through the drugstore pharmacists, thus are limited in extent, which confirms gaps of information and collaboration in this RL system [17,37]. The municipal MRLS does not have campaigns as a principle, but local communities are mobilized to deliver the medicine schemes and integrate other public and private agents in task forces [68–71].

4.2. Procedural Comparative Assessment of the MRLS Outcomes

The pivotal difference between the federal and the municipal MRLSs in the procedural dimension of SA is the technical capacity of the former to organize and coordinate routines and procedures. As a result, the federal system is highly standardized in comparison to the local system, which is reflected in the existence of their reports on quantities collected. Thanks to the mandatorily created PMG, in 2021 the federal MRLS promoted training of the participants of the RL schemes. This represents an advancement claimed by scholars that have earlier recommended the implementation of formalized routines in this system [7,37]. By contrast, the municipal MRLS suffered from unstandardized accounting. Responsibilities fell only on the pharmacists, as they needed to receive, sort, and store medicines, assess the physical integrity of such goods before re-dispensing, and decide about the best reverse route: the correct discharge or reuse [68–71,76]. According to the RS A pharmacists, there is not much time to process records on physical and monetary quantities, although the municipal law requires them to do so [76].

In the municipal MRLS, there are no common guidelines to be followed by the pharmacists with respect to how to make the records—whether accounting by units of boxes, or units of pills, or kilograms of received and redispensed medicines. According to information provided through interviews given by two pharmacists from RS A, the accounts of the received medicines are made by units (of pills or capsules), in the case of medicines presented in such forms. Nevertheless, a unit can be, for instance, a new (unused), sealed unit of ointment or syrup. Other pharmacies, such as SP A, accounted units as medicine boxes. This makes it impossible to properly compare the physical quantities that are transferred from the donors to the receivers when considering the municipal solidary pharmacies. Nonetheless, at least in RS A, the accountings of discharged medicines are informed in kilograms because of the landfill managers requirements. The monetary amounts of the received, redispensed and discharged medicines are estimated based on data from the

Brazilian National List of Essential Medicines [77] and from the Regulation Chamber of the National Health Surveillance Agency [78]. It is common that such pharmacies receive units and even small batches of expensive medicines from distributors or other pharmaceutical supply agents from time to time, which biases the monthly monetary accounts, because the most commonly donated and demanded products are cheaper.

4.3. Transactive Comparative Assessment of the MRLS Outcomes

In addition to the socioeconomic and economic aspects, transactive assessment also targets the timeliness of policies and programs [22,23]. The federal MRLS is scheduled to deploy in two phases (2021–2023, and 2023–2026), with application expanded to municipalities with at least 100,000 residents in 2023, and expected revision in 2025. This system spreads the costs of the RL between all stakeholders. Retailers must pay for the medicine collectors; distributors, for the specific packs to protect the delivered medicines; industry and importers must pay for the final disposal; and all of these parties must share the transportations costs [63]. In such respect, the federal MRLS shows transactive coherence with the principle of shared responsibility [27,33].

In the local MRLS, timeliness is not priority and the duration of the public programs depends heavily on the political situation. The municipalities must pay the costs of all the routines [69–71,76]. This sometimes includes the collection of free samples of medicines, and of donations that can only be made using public vehicles, and the establishment of medicine collectors in public schools, basic health units, and in other partners of the solidary pharmacies according to the RS A pharmacists. Furthermore, the wages of the professionals that work specifically in the MRLS must be covered by the municipal authorities, as well as the costs of correct discharge. Nonetheless, these are burdens aligned with circular economy thinking [25,38] that characterizes the evolution of the MRLS beyond the linear return flows. Because redispensing is a routine in the municipal MRLS, there are benefits other than simply economic benefits. They must fulfill requirements such as minimum age (18 years old), medical prescription presentation [68–71,76], identity document presentation, and proof of residence in the municipality that provides the medicines. In the RS A solidary pharmacy, the benefited persons need to sign a term of agreement that the public authority is not obliged to provide continuous redispensation, as it depends on community collaboration to have medicine supplies.

4.4. Economic Costs X Estimated Performance of the MRLS

According to [71], in the federal system of medicine returns, 52.7 tons of medicine were collected through the joint efforts of four national organizations: Logmed [67], Brazil Health System (BHS) [79], Interfarma [80], and Novartis [81]. The monetary amounts were not made available. Table 4 shows the collected amounts (in kg), the number of covered municipalities, and the respective number of collection points in the calendar year of 2021. From these data, considering that the municipalities involved account for 70,000,000 residents [67], it is found that the national system has avoided the incorrect discharge of 0.75 g per capita, and collected an average of 14.4 kg per collection point.

Table 4. Physical outcomes of the Brazilian medicines RL system in 2021.

RL Plan	Collected Amounts (kg)	N of Covered Municipalities	N of Collection Points
LogMed	37,188,480	69	3322
BHS	1,200,000		33
Interfarma	13,340,000		217
Novartis	10,510,000	5	82
Total	52,779,480	74	3654

Source: Adapted from [71].

With respect to the municipal MRLS, the physical units cannot be compared among the pharmacies because they do not standardize the accounting procedures and measuring units. That is why the full data provided by the RS A pharmacy on physical quantities were not reported. For 2021, the socioeconomic costs of six pharmacies (SP A, SP B, SC A, SC B, SC C) are presented in Tables 5–7. Table 5 displays the demographic data, taken from an official governmental database [72], showing the total number of residents, the proportion of the population with income of half of the Brazilian minimum wage in each municipality, and the already estimated number of persons that received medicines at the solidary pharmacies—all calculated from unstructured data, except for RS A.

Table 5. Demographic data of the municipalities—averages from 2021.

Pharmacy	N of Residents	Population with Half of Minimum Wage Income (%) [1]	Estimated Average Number of Served Persons in 2021	Estimated Average Served Population with Medicines Redispensed over the Total Residents (%)
RS A	73,758	20.5	7299	9.9
SP A	720,116	27.8	29,218	4.0
SP B	128,432	48.2	5874	4.6
SC A	366,418	20.6	24,000	6.5
SC B	219,393	26.2	15,157	6.9
SC C	72,931	21	5500	7.5
Average	263,508 [2]		14,508 [3]	
Total	1,581,048		87,048	

[1] These data refer to 2010. [2] These data refer to the average number of residents of the six municipalities in 2021. [3] These data refer to the estimation of the total average of the needy persons that would be served per year in each of the six municipalities.

Table 6. Monetary values of redispensed medicines and estimated value of redispensed medicines in 2021.

Pharmacy	Estimated Values Redispensed to the Whole Population [1] (USD)	Estimated Per Capita Values Redispensed to the Population with Half of Minimum Wage Income [1] (USD)	Estimated Per Capita Values Redispensed to the Beneficiaries [2] (USD)
RS A	4,918,358.64	325.3	673.8
SP A	48,019,045.42	239.9	1643.5
SP B	8,564,150.83	138.3	1457.9
SC A	24,433,622.62	323.7	1018.1
SC B	14,629,646.38	254.5	965.3
SC C	4,863,212.32	317.5	884.2
Average	17,571,339.37	266.5	1107.1
Total	122,999,375.6		

[1] These data refer to the potentially benefited population of each municipality, except RS A, whose data were given. It is assumed that the per capita redispensed value of the total residents of each municipality was USD 66.68 because the estimations were based on demographic data [72]. [2] Estimated values transferred to the served population (patients).

Table 7. Costs and estimated costs of discharged medicines in 2021.

Pharmacy	Total Costs for Environmentally Correct Disposal (USD)	Per Capita Costs for Environmentally Correct Disposal Considering the Population with Half of Minimum Wage Income (USD)	Per Capita Costs for Environmentally Correct Disposal to the Beneficiaries (USD)
RS A	503,521.5	33.3	68.9
SP A	4,915,994.4	24.9	168.2
SP B	876,762.9	14.2	149.2
SC A	2,501,414.8	33.1	104.2
SC B	1,497,723.7	26.0	98.8
SC C	497,875.9	32.5	90.5
Average	1,798,882.2	27.3	113.3
Total	12,592,175.53		

From Table 5, it is found that 1,581,048 residents would be potentially covered by the municipal MRLS in 2021, which represents 2.2% of the residents included in the first phase of the national RL system [71]. Additionally, from these data it is possible to conclude that SP A is already potentially part of the national RL system because it holds more than 500,000 residents, and cities with this population size are part of the LogMed [67]. Thus, SP A is covered by both MRLSs.

Brazil has 302 municipalities with a population between 70,000 and 355,600 residents [82], and the whole of the population of the above listed municipalities, except SP A, accounted for 860,932 persons in 2021. If all 302 municipalities implemented their solidary pharmacies, they would potentially cover at least 10.4% of the Brazilian population—Brazil has 203,062,215 residents [72]. Table 6 shows data of the monetary values redispensed by RS A, and estimations of values redispensed by other municipalities. Data were calculated to the whole population of each municipality, to the population with minimum income of a half of the Brazilian minimum wage in each municipality, and to the benefited persons that went to pharmacies take medicines.

From Table 5, it was found that the six municipalities redispensed a total average value around USD 17.5 million to their residents, and that the beneficiaries received an average per capita of USD 1,107.1—a considerable socioeconomic delivery that, at the same time, improves the circularity of medicines, providing ecological savings, albeit temporarily.

From the values displayed in Table 7, it is found that, in 2021, the municipalities paid USD 12,592,175.53 to protect the environment from incorrect medicine discharges. It is not possible to compare the monetary investments of the pharmaceutical business sector and the municipalities in environmental protection regarding the collected medicine waste because the LogMed [67] did not disclose the monetary expenses of its RL system.

The per capita investment in correct discharge to the whole population of the six municipalities is estimated as USD 6.8; this is assumed as the same value per capita for all studied municipalities, in proportional estimation. The population with income of half of the Brazilian minimum wage of the six municipalities would receive an average environmental investment per capita of USD 27.3 in 2021. With respect to the estimated number of beneficiaries, the average investments of the municipalities to prevent environmental hazards of medicines reached USD 113.3 per capita.

5. Final Remarks, Limitations, and Suggestions for Future Research

Organized MRLSs are a novelty in Brazil. Since 2020, a formal federal MRLS has been shaped after more than one decade of discussion amongst the supply chain business stakeholders [6]. At the same time, diverse local initiatives have been running since at least 2002 with the community aim of readdressing and properly managing medicines at the

end-of-life stage. This paper provides a novel opportunity to understand how these two diverse MRLSs are evolving and what their outcomes are—the first one typically linear, and the second leaning towards circularity [13] and closed loops [33,38].

To achieve this objective, the perspective of sustainability in RL [24–26] and the traditional SA recommended to the evaluation of politics, policies, and programs [21–23] were adapted into a MRLS SA framework. This intermediary step enabled the organization and the assessment of both RL systems according to four dimensions: normative, substantive, procedural, and transactive. In this SA adapted framework, the normative dimension is more important than the others, because the Brazilian MRLSs are ruled by a federal decree at the national scale, and by municipal laws. Such legal instruments set principles, concepts, and procedures to structure the routines of the medicines' reverse flows. It was possible to realize that the dimensions of SA in the federal and in the municipal MRLS are far from what is recommended by academic studies on RL and sustainability [7,27,28,33].

With respect to the substantive dimension, both systems show incipient understanding of the achievement of shared responsibility and inertia relating to the full social participation incentive given the limited participation of the consumers as agents of return. In actuality, the MRLS fail to create attractive strategies to gain buy-in from consumers [43,44] and to instigate a sense of participation towards their purposes and routines [7]. Formally, the principle of RL as a tool for socioeconomic development results in many management failures with respect to coordination, integration, and collaboration [37].

From a procedural dimension, the federal system has much to teach the municipal system in terms of rapid coordination and standardization, while the local system has as its main contribution to the federal system the partnership-building capacity and community mobilization. A common weakness of these MRLSs is that they rely on the transactive dimension. The business stakeholders of the MRL and the solidary pharmacy professionals, in different forms, neglect the importance of governance and data collection, which are signs of gaps in transparency and coordination in any RL system [7,14,26,37]. There are even difficulties in comparing the socioeconomic and economic performance because the local system is tailored to reuse and disposal, and the federal system is objectively guided by linear flows of collection for disposal, thus they depart from a diverse mindset in terms of what is the current meaning of RL to the whole society, and focus more on the meaning of RL to the business itself.

Brazilian municipalities have mobilized capacity building measures and resources to reduce inequalities with respect to access to medicines by needy people through the creation of medicine reuse laws [14,19]; however, these activities are still invisible and neglected by the institutionalized pharmaceutical supply chain, mainly in the name of curbing risks to public health [14].

The core limitation of this study is the lack of data and availability of the majority of the stakeholders to openly reflect about the premises and fragilities of their respective systems. It is necessary to highlight that all the provided estimations calculated in this research are underpinned by the results obtained from the RS A solidary pharmacy, which are far from being precise because the pharmacists of this municipality made clear the difficulties they experienced in trying to keep routine records. These professionals argue that they cannot check the values of unknown items because of time constraints associated with their tasks, especially the sorting.

The gaps in information and disclosure occurring in this research reinforce doubts about the ways in which medicines that are returned, while becoming public goods, are properly managed and addressed [62]. In the case of solidary pharmacies, a large part of the activities required for the MRLS are performed by a few stakeholders. Conversely, in the federal MRLS, it is arguable the dispersion of efforts among a greater diversity of stakeholders hinders coordination, and results in a focus on easing the economic burden rather increasing circularity.

For future studies, it is recommended to investigate: the mechanisms and tools through which the local MRLS can better organize and normalize their routines and records; the way

through which the federal MRLS stakeholders make decisions on collection campaigns and collection points location; the way in which pharmacists interact with consumers to promote delivery actions; the motivations and commitments of the consumers for participating in collection campaigns; and the possibilities for convergence between the two RL systems.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su152014675/s1, This Supplementary Material displays the quantitative data collected and the calculation of the estimated values presented in this research.

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