

## **Sustainability indicators in cooperative management of recyclable materials**

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**Abstract.** Following the promulgation of the National Solid Waste Policy in 2010, legal provisions, government programs and sectoral agreements have been implemented, but without the expected efficiency in relation to recycling. It should be noted that Cooperatives of Recyclable Material Pickers (CRMP) should play a leading role in this regard, but they do not have adequate management to be economically, socially and environmentally sustainable, depending on assistance to maintain the activity. Aiming to elucidate this issue, in this paper was made an institutional diagnosis of the category of waste pickers using the Gramacho region in the city of Duque de Caxias (Rio de Janeiro) as a case study. It was carried out an evaluation of the historical context of the neighbourhood, and it was drawn up a semi-structured questionnaire in 12 of the 18 cooperatives in the region. The data were interpreted through a SWOT matrix and the Venn diagram. A matrix was proposed and elaborated with 15 sustainability indicators specific to the CRMC reality in order to evaluate and monitor the management of cooperatives. After collecting the primary data, it was possible to validate the matrix of indicators with indexes of cultural, economic, political and ecological sustainability of the cooperatives. It was found that the matrix of indicators facilitated the understanding of the data and the comparison between the indicators. This tool can help decision-making, creation of action plans and identification of demands by the cooperative waste pickers themselves, without the presence of an analyst or technician.

**Key words:** matrix of indicators, planning, pickers, solid waste.

### **INTRODUCTION**

In Brazil, 62.78 million tons of solid waste were collected in 2018, but of this volume, the mass of recyclable waste collected selectively was only 1.7 million tons (Brasil, 2019). Thus, 75.6% of the waste was disposed of in landfills, while 24.4% was improperly disposed of in dumps and controlled landfills (Brasil, 2019). The use of strategies and indicators can help to find effective alternatives for waste disposal (Chotovinský & Altmann, 2018), either for collection or for the best destination (Mimra et al., 2016; Chotovinský & Altmann, 2017).

No Brazil, the integrated management of Solid Waste (SW) recommended by the National Solid Waste Policy – PNRS, law number 12305 (Brasil, 2010a) involves different stakeholders: public sector, private sector, consumers and pickers' cooperatives.

The Decree number 7404 (Brasil, 2010b) regulated the management of solid waste, which underwent profound changes. In this sense, legal provisions, public policies and sectoral agreements included recyclable material pickers, which, before the PNRS, were ignored.

The challenge after the enactment of the PNRS is how to include waste pickers in the recycling market, ensuring autonomy, competitiveness and financial and / or administrative independence.

The survey of basic sanitation data in Brazil (Brasil, 2019) points out that the lack of knowledge about the performance of waste pickers' cooperatives is not rare among municipalities in the country. Even so, with the government, in a formal partnership, the pickers were responsible for 30.7% of the total tons collected selectively in 2018 (Brasil, 2019).

Even with the technical and financial support invested in hundreds of cooperatives throughout Brazil, a balanced and effective development pattern for the category has not yet been established. When only investment plans focused on acquired rights are implemented, without the prerogative of any counterpart or results on the part of the cooperatives, the efficiency of the project is compromised. For that, clear notions about the main conditions that involve the organization and development of Cooperatives of Recyclable Material Pickers (CRMP) are needed, in an accessible and flexible way to local demands. Sustainability indicators can assist in the provision and interpretation of data for both the self-management of CCMPs and it can support in feeding and interpreting data for the National Solid Waste Plan (MMA, 2016)

According to Fiksel, Eason & Frederickson (2012) a sustainability indicator can be defined as an aspect of the economic, environmental and social systems that can be measured, thus assisting to monitor changes that may occur in the characteristics of these systems that are relevant to maintaining human and environmental well-being. Thereby, Garrett & Latawiec (2015) emphasize that of indicators should be simple, measurable, feasible, flexible, dynamic and user-inspired.

The definition of a management strategy developed in stages, generating a Matrix of Indicators that can be used autonomously and continuously by the cooperatives, in addition to facilitating decision making, helps in the identification of objectives and goals, allowing to compare different projects and diagnoses. This methodology can also be applied in other enterprises, rural or urban, that seek to implement a matrix of indicators for monitoring.

It should be noted that the National Information System on Solid Waste Management (SINIR) is based on public data sources, considering states and municipalities, as mentioned in its objectives: 'monitor trends in relation to the goals of reduction, reuse, selective collection and recycling of solid waste to be achieved by the logistics system and public selective collection services (MMA, 2016)'.

In addition to the public sector, SINIR has as a data source the industry and waste operators, but it does not involve CRMP, despite the various allusions to them, in different articles of the same Decree number 7404 (Brasil, 2010b). Data generation and process control are important tools for management and monitoring, and in the case of integrated management, they are crucial, as they involve different stakeholders. Even defining responsibilities, the actions implemented must be developed in a balanced way and, for that, monitoring / planning at all levels must be effective.

Buque & Ribeiro (2015) found that although the amount of waste is used as an indicator of the efficiency of the collection system and the quality of the separation at the generating source and at the sorting plant, the data collected in Maputo (Mozambique) indicated that most organizations did not gather the information, making it difficult to estimate the generated waste. Another limitation found by Buque & Ribeiro (2015) concerning the management of the selective collection enterprises was the deficient financial analysis and lack of working capital, allied to the lack of remuneration for the collection and sorting, with the revenue coming only from the sale of recyclable materials.

Regarding the management of cooperatives in South Africa, Muswema et al. (2019) report that some of the challenges to be overcome are the reduced ability to manage enterprises due to the low qualification of the members of the cooperatives; low financial confidence among members, predominance of individual interests to the detriment of the collective and low self-sufficiency. The authors signalize that the survival rate of waste-related cooperatives in South Africa is low, around 8%.

Thus, in this study, a Matrix of Sustainability Indicators was suggested, according to different dimensions: economic, social, environmental and cultural, for Recyclable Material Pickers' Cooperatives using the Jardim Gramacho Neighborhood as a case study in the municipality of Duque de Caxias - RJ.

Based on the concept of 'Local Sustainable Development', the diagnosis of the local reality was carried out, where positive and negative components, internal and external, were analyzed in order to identify the current scenario and the desired future scenario. There is a strong relationship between the neighborhood and the issue of recycling because there is a contingent of more than 200 waste pickers organized in seventeen cooperatives that have a strong influence on local daily life. It is noted, therefore, that an action plan aimed at the development of CRMP tends to have a relevant social, economic and cultural impact. This can present itself as an example of thinking globally and acting locally, according to the precepts of 'Model management of the United Nations Global Compact' (United Nations, 2010).

In this sense, the development and validation of the Sustainability Indicator Matrix, has the general goal of promoting and monitoring the development of cooperatives, and the methodology can be used for other types of enterprises. Thus, the aim of this paper was to identify steps that could be followed so that small enterprises or organizations could make their management sustainable and participate in public policies.

## **MATERIALS AND METHODS**

The development of this work was done adapting the approach proposed by James (2014a) used in 'Circles of Social Life', which was based on the UN Global Compact Management Model. Thus, the paper was divided into the following steps:

- 1) The first stage - Commit: in this stage, the commitment regarding the proposal presented that promotes local development must be publicly stated, defining who will be responsible for managing the proposal, the question to be elucidated, and the general objective, as well as the necessary resources. This step was under the responsibility of one of the cooperatives whose president was involved in the project. The objectives of the work to be developed and how the matrix of indicators would be developed and

applied were presented in meetings at the cooperatives and the Community Forum of the neighborhood of Jardim Gramacho.

2) The second stage - Involve: in this stage, stakeholders are identified concerning the main issue of the project, which in this work is the promotion of waste recycling. The participation of those involved in the proposal is also sought. Thus, the cooperatives were informed about the project and its functions. Data were collected on the main local institutions and associations based on searches in the 'GoogleMaps' application and exploratory research following the concept of Gil (2008); at meetings of the Jardim Gramacho community forum and in the City Hall of Duque de Caxias (RJ).

3) The third step - Evaluate: in this step, the relevant information was determined, which data sources could be used. The cooperatives strengths and weaknesses were raised. The indicators usual collected were identified. It also identified what was the public and political involvement of the cooperatives, researching the social context in which they were involved, what would be the driving forces for local development, evaluating, therefore, the local reality and projecting future scenarios.

For the case of the community of Jardim Gramacho, there are no specific studies of the neighborhood, but through the census of the Brazilian Institute of Geography and Statistics (IBGE, 2010) it was possible to establish parameters considering data from the municipality of Duque de Caxias. It was also necessary to outline the profile of the institutions, with semi-structured interviews were conducted with each president of the cooperatives, according to the concept of Laville & Dionne (1999), to identify the different aspects that involve the full development of the Cooperatives, according to the sustainability dimensions addressed in 'Circles os Social Life' (James, 2014a).

Interviews were carried out containing 118 questions, the questions were divided into 8 sections, the different aspects of sustainability were questioned, and the strengths, weaknesses, threats, and opportunities of cooperatives were instigated as an institution and as part of a category (Networks / Federations).

The interview data were categorized into significant internal and external environmental factors for the CCMR, filling in the SWOT matrix (Fortaleza, Oportunidade, Weakness, and Threat). SWOT analysis was adopted because it is a tool generally used in the audit and analysis of the strategic position of a project or organization and its surroundings according to Osita, Idoko & Nzekwe (2014). To view the institutional network in the area surrounding the cooperatives to identify possible alliances and partnerships to promote local development, according to the concept of Buarque (2008), the 'Venn Diagram' was used. The Venn diagram is commonly used in participatory diagnostics because it graphically represents the relationships between groups in a community, facilitating the understanding of the role and importance of each and aiding decision making, having been applied according to Sarmiento, Ferreira and Hurtado (2009). In the 'Venn Diagram', stakeholders were represented by circles arranged at different distances from the center of the diagram. This distance represented the institution's influence in the neighborhood, according to the frequency and intensity criteria of its performance. The interpretation of the 'Venn Diagram' allowed the projection of future scenarios.

4) The fourth stage - Define: in this stage the initial objective must be compared with the data collected in the previous stages, to assess the need for its alteration and to verify which indicators can be used to monitor the subsequent stages. The data from the interviews and the Venn diagram were evaluated. The indicators used in the Waste Pickers Project (CRS) were used as a basis.

The CRS project analyzed the socioeconomic and demographic profile of waste pickers in 41 municipalities in the state of Rio de Janeiro (PANGEA/FGV, 2013) using 20 indicators, divided into three analytical dimensions. Consolidated works and research using indicators for waste picker organizations were also used, such as Besen (2011). Thus, the proposed matrix of indicators was weighed against the risks and challenges involved in achieving sustainability in cooperatives. The current legislation, which regulates the activity directly and / or indirectly, was also considered as the basis for defining the indicators, the main ones being: National Solid Waste Policy (Brasil, 2010a), Federal Decrees number 7404 (Brasil, 2010b) and number 7405 (Brasil, 2010c) and the Cooperativism Law (Brasil, 1971).

5) The fifth stage - Implement: this stage puts the project into action, defining responsibilities and revising the initial proposal whenever necessary. Thus, the indicators that would make up the sustainability matrix for cooperatives were defined. The indicators were grouped adapting to the different domains of sustainability according to the methodology of James' 'Circles of Sustainability' (2014b): economic (Production, Income, Commercialization, Institutional Support, and Control), ecological (Safety and Quality of Life at Work, Infrastructure and Final Destination of Waste), political (Formalization, Partnerships, Market Insertion) and cultural (Schooling, Training, Communication and Social and Environmental Responsibility). Qualitative data were converted into quantitative data by categorization, according to the Kronemberger methodology.

Data collections were made through interviews carried out between July and August 2016. The questions used were the cooperative's self-assessment so that they could be reassessed and compared whenever necessary. Gradation questions were also elaborated that allowed to verify what were the urgent demands and to compare them with the essential demands (which if solved would cause a greater impact), according to Kronemberger (2011).

The answers were translated into different indicators, each according to the different domains of sustainability, and the more affirmative answers, the closer to the ideal of sustainability the cooperative would be. The results of the characterization were organized in indices presented together with the weighting scale from 0 to 10 of the aspects raised: Cultural Index, Economic Index, Ecological Index, and Political Index; aiming at qualifying how they are affected and benefited. Thus, the CMRP Sustainability Circle was created, with the Sustainability Indicator Matrix, compiling data from all CMR cooperatives evaluated so that they could be used by development agencies and governments for actions to improve the recycling process, cooperatives as tools. The Economic, Ecological, Political and Cultural Sustainability Indexes were obtained according to the formulas shown in Table 1.

**Table 1.** Formulas used to obtain Economic, Ecological, Political and Cultural Sustainability Indexes

Indexes	Equations
Economic	$EDI = \frac{I(in) + I(comz) + I(is) + I(ct)}{\text{number of indicators considered}}$
Ecological	$ELDI = \frac{I(slq) + I(Inf) + I(dot)}{\text{number of indicators considered}}$
Political	$PDI = \frac{I(for) + I(art) + I(mi)}{\text{number of indicators considered}}$
Cultural	$CDI = \frac{I(scho) + I(tra) + I(comm) + I(sr)}{\text{number of indicators considered}}$

Where: *EDI* = Economic Dimension Index; *ELDI* = Ecological Dimension Index; *PDI* = Political Dimension Index; *CDI* = Cultural Dimension Index; (*in*) = income; (*comz*) = commercialization; (*is*) = institutional support; (*ct*) = control; (*slq*) = safety and life quality; (*Inf*) = infrastructure; (*dot*) = disposal of tailings; (*for*) = formalization; (*art*) = artnerships; (*mi*) = market insertion; (*scho*) = scholling; (*tra*) = training; (*comm*) = communication; (*sr*) = socioenviromental responsibility.

The indices were organized under the same scale (from 1 to 10) so that the comparison was possible. With the indices, the Matrix of Indicators represented in a Sustainability Cycle was created, considering the results of all the CMR cooperatives participating in the research.

The scale was made with different drawings and shading in which the evaluation varied from ideal to critical (Table 2). Thus, the circle was divided into four quadrants, and within each quadrant, the slices represent each indicator. The order of the indicators mentioned in each quadrant is the same as the respective slices, that is, always read by quadrant and from top to bottom, according to the exposed order of indicators underlying the name of the Sustainability Dimension. Each slice represents an indicator and the slice radius represents the weighted value of the indicator. The gradation of each indicator varied from 0 to 10, thus varying from critical to ideal.

**Table 2.** Scale of Sustainability Indexes of Waste Pickers' Cooperatives

Scale	Representation	Rating
10		Ideal
9		Vibrant
8		Good
7		High satisfaction
6		Satisfactory +
5		Satisfactory
4		Satisfactory -
3		High dissatisfaction
2		Bad
1		Critical

6) Sixth stage - Monitor: In this stage, progress is verified concerning the achievement of objectives and goals, and indicators are monitored. The matrix created in the previous step was validated with its application in one of the cooperatives in the municipality of Duque de Caixas: Cooper Ecológica. The primary data available were used in the equations of the indicators, finding the sustainability indexes. Cooper Ecológica's Social Sustainability Circle was designed to facilitate the communication of results. In the Sustainability Circle, the 15 indicators were arranged according to the four aspects of Sustainability: Economic, Ecological, Political and Cultural.

7) The seventh stage - Communicate: this stage seeks to disseminate the results to the community in accessible language. Each cooperative received its responses to the applied questionnaire. The sustainability circle was explained so that the results were understood. Only the technical staff had access to the responses of all cooperatives.

## **RESULTS AND DISCUSSION**

In the first stage of the project, meetings were held with the cooperative managers, on-site visits and direct contact by the media, presenting the proposal and checking the interest in participating. Of the 17 cooperatives in the Jardim Gramacho neighborhood, only 12 accepted the invitation.

In the second stage, a survey was made of which people, institutions and organizations were linked to the recycling process in the region. In the district of Jardim Gramacho, there are other types of enterprises linked to recycling that work together with the 17 local CMR cooperatives.

The stakeholders of Neighborhood de Jardim Gramacho in the recycling area are associations, non-governmental organizations, city hall secretaries, schools, health units, companies and the cooperatives themselves.

In the third stage, the internal and external environments of the cooperatives were evaluated. Because it housed one of the largest dumps in Latin America for 34 years, the Jardim Gramacho neighborhood, Duque de Caxias, developed its territorialities, mainly focused on recycling.

When planning actions aimed at the balanced development of cooperatives, it is relevant to have knowledge of the internal scenario and of which it is inserted. The S.W.O.T. matrix was organized based on information obtained through a questionnaire applied to 12 cooperatives in the neighbourhood of Jardim Gramacho. The demands and potentialities that had the greatest recurrence in the results were highlighted (Table 2).

Among the strengths shown in Table 3, the privileged location of the cooperatives can be highlighted, close to important roads in the country such as BR-040 and the municipalities that make up the metropolitan region of the municipality of Rio de Janeiro, which facilitates both the entry of material recycled as for disposal for sale. In addition to this fortress, it is worth mentioning the experience and specialization in the field, since the cooperative members are in a neighborhood, which was influenced by the operation of one of the largest landfills in Latin America for more than three decades.

The main weaknesses are mainly related to the lack of control of the entry and exit of material, together with the lack of updating or the absence of a cash book, since these factors prevent the taking advantage of opportunities. It can also be highlighted the inadequate destination of the tailings generated after the material was sorted, which negatively impacts the environment and can also damage the image of the cooperatives vis-à-vis other sectors of the neighborhood and the population.

The opportunities (Table 3) are mainly linked to the technical and financial support of public and private institutions, and the payment for the service of collection, sorting and proper final disposal of recyclable waste, which can be considered an internalization of the waste disposal costs, which for some sectors it is still considered an externality.

The threats (Table 3) are mainly linked to municipal management, through public policies of mechanization of waste sorting and political discontinuity, when there is a change of government, without the inclusion of cooperatives in the process.

The articulation between the different stakeholders has a greater social, ecological, economic and cultural impact on the whole neighborhood. For this to happen, it is necessary to know what these institutions are, what situation they are experiencing, what they intend for the future, the degree of engagement with the community and their level of social and economic development.

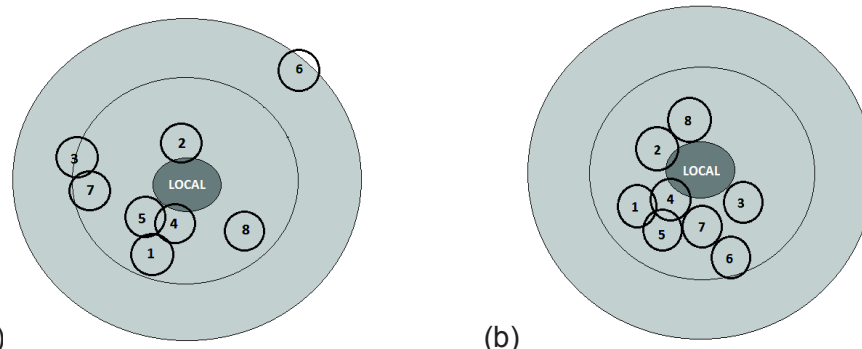
**Table 3.** Strengths, Opportunities, Weaknesses and Threats in CRMP

INTERNAL FACTORS		
STRENGTHS	WEAKNESSES	
P Womem empowerment;	Deficiencies in basic infrastructure:	N
O Experience in the business;	water and sewage network; equipment	E
S Privileged location for waste	High illiteracy rate	G
I management logistics, as it is close to	Informalization of most cooperatives;	A
T highways and economically important	Lack of internal and external process	T
I cities;	control;	I
V Supply of specialized labor;	Most of the updated cash-book	V
E Fixed income guarantee	cooperatives are lacking;	E
E Participation in networks	Inadequate waste disposal.	
F Accountability to participants	Most of the material sold to	A
A intermediaries		C
OPPORTUNITIES	THREATS	
C Presence of commercial and industrial	Lack of basic infrastructure: public	T
T activities related to recycling close to the	lighting, pavement;	O
O cooperatives.	Insecurity: overt presence of violence;	R
R Reverse Logistics Sector Agreements	Economic crisis;	S
S Technical / financial support from public	Vulnerability to climatic conditions (rain	
and private institutions;	/ heat);	
Payment for collection service, sorting	Political and administrative	
and proper final disposal of recyclable	discontinuity;	
waste.	Lack of public policies to encourage the	
	recycling sector;	
	Mechanization of waste collection and	
	sorting;	
	Creation / Implementation of public	
	policies that encourage recycling through	
	large multinational companies.	
EXTERNAL FACTORS		

The Venn diagram was designed to illustrate the interactions between the institutions, to understand how each could act to promote sustainable local development in the neighborhood. It should be noted that the Diagram is the representation of interactions at a given moment. Kronemberger (2011) points out that ‘the closer the circle is to the center, the greater the institution’s influence on development, meaning that it acts directly in the daily life of the community and with daily or weekly frequency’. According to author, the intersection between the circles shows that there is some form of relationship between the institutions. The institutional network in the area



surrounding the cooperatives is presented in Fig. 1, actual and ideal scenario, respectively.



Legend: 1 – Associations; 2 – non-governmental organizations; 3 – Public Bodies; 4 – Teaching Units; 5 – Health Units; 6 – Companies; 7 – Cooperatives; 8 – Churches.

**Figure 1.** Venn Diagram Model – Current Scenario (a) and ideal scenario (b).

Through the interview conducted with the cooperative members, it was verified that public agencies do not seem to have the expected role, despite presenting themselves as supporting agents for projects in the community. Its close relationship with the cooperatives is due to a specific structuring project aimed at seven cooperatives in the neighborhood to meet the National Solid Waste Policy, implementing Solidary Selective Collection. It was also found that companies based in the neighborhood often do not employ local labor, and when they do, it is for positions that require little qualification. There is no consolidated employee training plan or career plan.

Cooperatives also do not operate in the community with the frequency and intensity that they should. Although cooperatives are the means of formalization and organization for waste pickers, it was found that this in practice does not work satisfactorily, since the cooperatives posture is not very proactive, not promoting good practices and entrepreneurship.

The major community service providers in the region, due to the degree of involvement with cooperative waste pickers, are the Teaching Units, Health Units, and Associations. These stakeholders are more influential in the neighborhood and show concern for the quality of life of the community, despite suffering from external threats to their management and other internal barriers to the institutions. And NGOs work in the community independently, without broad planning that seeks to share information and demands for the neighborhood.

In the ideal scenario (Fig. 1, b), there would be greater integration between all organizations and greater frequency and intensity of stakeholder actions in the neighborhood. Public agencies, although close, would not imply dependency. The cooperatives would form networks with the other institutions (Public and Private Schools) to use the potential of these institutions for the development of Environmental Awareness projects. Health units could relate to cooperatives by offering lectures to raise awareness of the use of Personal Protective Equipment (PPE) in the workplace in the prevention of accidents and occupational risks. And public institutions would act to

foster the creation of collaborative networks between companies, schools, health units and cooperatives, for the development of commercial partnerships (such as the donation of recyclable waste). Besides, public institutions could support the creation and implementation of waste management plans that can be converted into job and income generation to reduce the population's situation of social vulnerability and also qualify them for the job market.

In the fourth stage, the data obtained in the previous stage were evaluated considering the main issue to be solved and the general objective to achieve the solution. The motivating issue was the guarantee of CRMP's autonomy, competitiveness, and financial and administrative independence. The general objective to elucidate this issue was the creation of a tool that would allow cooperatives to evaluate their management, identifying their strengths and weaknesses, their opportunities and threats to set goals for their development.

The 'Matrix of Indicators' was created based on the results found in S.W.O.T. (Table 3).

The indicators were grouped into four different Dimensions of Sustainability: Cultural, Economic, Ecological and Political. Within the dimensions, key indicators were chosen to better diagnose the reality of CMR Cooperatives.

The starting point was primary data that could produce history to monitor the evolution of the performance of each cooperative and that the cooperatives themselves could collect autonomously and complete the spreadsheet created to generate the matrix, without the need for support specific technician. In the fifth stage, the 15 indicators were defined, organized in 'Sustainability Indexes'. In calculating the value of the indicator, a factor was used to maintain the final value on a scale of 1 to 10. The indices present the weighted sum of each set of indicators according to the dimension to which they refer (Table 1).

### **Cultural Dimension Index**

The Cultural Dimension Index (CDI) represents the degree of involvement of cooperatives with the recycling market and with the community, that is, how the cooperative relate socially. In this index, the indicators that indicate the level of education of the cooperative members were considered, also considering the different modalities of communication of the cooperatives with their customers, partners, and community.

The index also includes the development of public or private partnerships linked to environmental education or training for the population surrounding the cooperatives; and the development of training plans for cooperative members in the areas of management, processes, and efficiency. To maintain the Cultural Dimension Index in base 1 to 10 the equation was multiplied by the factor (0.25). The representation of this index is presented in Eq. 1 below:

$$CDI = (Education + Training + Communication + Responsibility) \times Factor \quad (1)$$

where *CDI* – Cultural Dimension Index; *Responsibility* – socioenvironmental responsibility; *Factor* – 0.25 (Base index: 1–10).

The indicators that make up the Cultural Index equation were obtained using the equations presented in Table 4 as a form of calculation. The factor that was used to standardize the scale is also presented.

**Table 4.** Index of cultural sustainability of recyclable material pickers' cooperatives according to the indicators that compose it

Indicators	Calculation form	Factor
Education	(Number of members with schooling equal to or higher than the complete average / Total number of members of the cooperative) *10	0.25
Training	(Gradation attributed to the participation of the members <sup>1</sup> + Number of Training Courses held in the last year <sup>2</sup> ) / 2	0.25
Communication	(Number of communication items present in the cooperative <sup>3</sup> + Gradation of the cooperative's relationship with other waste pickers' cooperatives <sup>1</sup> ) / 2	0.25
Socio-environmental responsibility	Action carried out to promote selective collection in the last year <sup>4</sup> / Interest in carrying out action to promote selective collection <sup>4</sup>	0.25

<sup>1</sup>Gradation: Poor = 1, Bad = 4, Good = 6, Very Good = 8 and Great = 10;

<sup>2</sup>Training courses: Administrative Management, Use of Computer and / or Computer Programs, Arrangement of production equipment – layout, Use of Collection Equipment, Sorting and Processing, Financial Management, Work Safety, Cooperatives, Marketing and others;

<sup>3</sup>Communication items present (if YES = 1 / NO = 0): Website, Blog, Folder or Institutional Brochure, Business Card, Facade Plaque (\* YES = 2 / NO = 0), Banners or Material for Events, Logo , Digital Presentation, Facebook;

<sup>4</sup>Action Done / Interest in: Schools = 3, Community = 3, Companies = 3, Not Done / Not interested = 1.

Based on Table 4 and using the data obtained in the interviews with the cooperative members, the values for the indicators were obtained, as well as the corresponding ‘Cultural Dimension Index’ for each of the evaluated cooperatives, presented in Table 5.

The names of the participating cooperatives of the work were replaced by numbers so as not to hurt the image right. Of the twelve cooperatives analyzed, 75% obtained an index lower or equal to 6, with values considered from bad to satisfactory. The highest index was 7 (High Satisfaction). Considering that all organizations are located in the same neighborhood, there was considerable scope between the cooperative with the the highest index (value 7) and the lowest(value 2).

These results point to the need for government action plans, as well as for the private sector, to improve education and training indicators, respectively. The Education Indicator is the worst among the indicators analyzed in this dimension. It appears that among the 12 cooperatives, the ones that most need action plans are cooperatives 5 and

**Table 5.** Results obtained in the analysis of cultural indicators of the cooperatives of Jardim Gramacho

CRMC	Education	Training	Communication	Socio-environmental responsibility	CDI
1	1	4	9	7	5
2	1	7	6	7	5
3	0	7	6	0	3
4	0	7	6	10	6
5	0	5	5	0	2
6	1	6	6	0	3
7	1	10	8	10	7
8	0	8	10	10	7
9	3	7	7	10	7
10	0	7	7	10	6
11	0	5	5	0	3
12	0	4	5	0	2

12 that obtained the worst result (2- Bad). However, cooperatives must act to improve communication and socio-environmental responsibility rates.

### Economic Dimension Index

The Economic Dimension Index (EDI) represents the degree of development of cooperatives taking into account the following indicators: production, income, commercialization, institutional support, and control. The representation of this index is presented in Eq. 2 below:

$$EDI = (Production + Income + Marketing + Control) \times Factor \quad (2)$$

where *EDI* – Economic Dimension Index, Factor – 0.2 (Base Index: 1–10).

The indicators serve to point out the efficiency and effectiveness of the collection, sorting, and marketing of recyclable waste through the income-generating capacity of the evaluated cooperatives.

In the marketing indicator, data on the consumer market and participation or organization in cooperative networks were considered. Institutional support was measured based on the grading attributed to technical or financial support from the public and private institutions. And for the control indicator, the existence of an updated Cash Book was considered, as well as the gradation concerning the control of the cooperative's waste flow (Input and output). The results obtained are shown in Table 6.

**Table 6.** Index and indicators of economic sustainability of recyclable material pickers' cooperatives

Indicators	Calculation Form	Factor
Production	(Quantity of material sold <sup>1</sup> / Quantity of material collected) multiply for 10	0.2
Income	Cash Fund <sup>2</sup> + Weighted Value (PV) of the Average Monthly Salary (MS) of the Cooperative in the last year <sup>3</sup>	0.2
Commercialization	To whom the cooperative sells sorted / processed waste <sup>4</sup> + Participation of cooperatives in Networks <sup>2</sup>	0.2
Institutional Support	Gradation attributed to financial / technical support from public institutions in the last year <sup>5</sup> + Gradation attributed to financial / technical support from the Private Sector in the last year <sup>5</sup>	0.2
Control	Gradation Control of input and output of material from the Cooperative <sup>5</sup> + UPDATED cash register of the cooperative <sup>2</sup>	0.2

<sup>1</sup>Average value month of last year (t);

<sup>2</sup>If you have: YES = 5, NO = 0;

<sup>3</sup>In view of the Minimum Salary (MS) based on IBGE: ≤ SM = 1, Up to 5% above MS = 2, Up to 25% above MS = 3, Up to 40% above MS = 4, > 40% above MS = 5;

<sup>4</sup>If sold: Most for Industry = 5, Smallest for Industry = 3, Exclusively for Intermediate = 1;

<sup>5</sup>Gradation: Bad = 1, Bad = 2, Good = 3, Very Good = 4 and Great = 5.

1 Average value month of last year (t) 2 If you have: YES = 5, NO = 0.3 In view of the minimum wage (SM) based on IBGE: ≤ SM = 1, Up to 5% above SM = 2, Up to 25% above SM = 3, Up to 40% above SM = 4, > 40% above SM = 5.4 If sold: Most for Industry = 5, Smallest for Industry = 3, Exclusively for Intermediate = 1.5 Gradation: Bad = 1, Bad = 2, Good = 3, Very Good = 4 and Great = 5.

The index of the economic dimension of the cooperatives in the neighborhood of Jardim Gramacho is shown in Table 7.

In Table 7 can be seen that all the analyzed cooperatives obtained an index equal to or greater than 5 (Satisfactory), standing out from the other indexes analyzed as the best as a set of cooperatives. It appears that 67% of the cooperatives obtained rates between 5 (Satisfactory) and 6 (Satisfactory +), representing that, despite the good performance, there is still a need for action plans for improvement. The Indicators that presented the worst result were Income and Institutional Support with an average of 4 (Satisfactory -), which may indicate a starting point for future action plans to improve the economic sustainability indexes of the group of cooperatives.

**Table 7.** Results obtained in the analysis of economic indicators of the cooperatives of Jardim Gramacho

CRMC	Production	Income	Commercialization	Institutional Support	Control	EDI
1	8	3	5	4	10	6
2	6	2	6	5	4	5
3	8	1	6	2	1	4
4	8	8	6	2	1	5
5	7	3	6	6	9	6
6	7	1	6	2	9	5
7	8	5	10	2	10	7
8	9	8	10	7	9	9
9	8	10	8	2	8	7
10	9	4	6	4	8	6
11	8	3	6	4	3	5
12	7	4	1	2	9	5

#### Political Dimension Index

The 'Political Dimension Index' represents the degree of development of the cooperatives taking into account the following indicators: formalization, partnerships, and insertion in the market. The representation of this index is presented in Eq. 3 below:

$$PDI = (Formalization + Partnerships + Market insertion) \times Factor \quad (3)$$

where PDI – Political Dimension Index; Factor – 0.20 (Base Index: 1–10).

How the indicators were considered, as well as the factor used is shown in Table 8.

**Table 8.** Indices and indicators of political sustainability of recyclable material pickers' cooperatives

Indicators	Calculation Form	Factor
Formalization	(Sum of the number of formalization documents that the cooperative has) <sup>1</sup> divided by eight	0.33
Partnerships	If the cooperative has a partnership (through Decree 5.940), with any company, agency, or federal government agency <sup>2</sup>	0.33
Market Insertion	Number of paid service contracts <sup>3</sup> divided by the number of unpaid service contracts <sup>4</sup>	0.33

<sup>1</sup>Formalization Documents (If YES = 10 / NO = 0): Updated Election Act, Updated Bylaws / Floor Plan and Land Status, Environmental License, Municipal Waste Transport Exemption, State Waste Transport Exemption, Exemption for Federal Waste transportation, Firefighters' Certificate, Municipal Permit;

<sup>2</sup>YES = 10 / NO = 0;

<sup>3</sup>Number of paid contracts: Up to 2 = 1, Up to 4 = 8, From 5 upwards = 10;

<sup>4</sup>Number of Unpaid Contracts: Up to 2 = 10, Up to 4 = 8, From 5 upwards = 1.

In the indicator of the degree of formalization presented in Table 8, it was considered whether all legal requirements related to documentation were met. In addition to the development of public and or private partnerships linked to physical and administrative infrastructure, the different types of service provision contracts and types of connection between cooperatives with the public and private sectors were also considered. A partnership is an indicator that promotes other indicators since, through partnerships, cooperatives improve their performance in income, control, among others.

The political index obtained with the indicators in Table 8 is shown in Table 9. It is possible to verify that 75% of the cooperatives obtained a political index equal to or less than 5 (Satisfactory). Among the four Dimensions of Sustainability, the Political index stood out as the worst, analyzing the set of cooperatives. Despite the cooperative identified by the number 8 having obtained a maximum index of 10 (Ideal), 42% of the cooperatives obtained the worst index 1 (Critical), which requires a deeper analysis. The data suggest the observation of the action plan of the cooperative number 8 to reach this index, checking the possibility of implementing it in the others or even using it as a goal for the other cooperatives to improve their indexes.

**Table 9.** Results obtained in the analysis of political indicators of the cooperatives of Jardim Gramacho

CRMC	Formalization	Partnerships	Market Insertion	PDI
1	8	10	0	6
2	3	0	0	1
3	3	0	0	1
4	3	0	1	1
5	4	10	0	5
6	4	10	0	5
7	8	10	1	6
8	9	10	10	10
9	5	10	1	5
10	4	10	1	5
11	4	0	0	1
12	3	0	0	1

### Ecological Dimension Index

The 'Ecological Dimension Index (ELDI)' represents the degree of development of the Cooperatives taking into account the following indicators: safety and, quality of life at work, infrastructure and disposal of waste. The representation of this index is presented in Eq. 4 below:

$$ELDI = (Safety\ and\ quality\ of\ life + Infrastructure + Tailings) \times Factor \quad (4)$$

where ELDI – Ecological Dimension Index, Safety and quality of life – Safety and quality of life at work, Tailings – Tailings destination, Factor = 0.25 (Base Index: 1–10).

The indicators were chosen to point out the efficiency and effectiveness of the actions and protocols implemented in the areas of safety and quality of life at work and infrastructure. The intention was also to point out how the waste generated in the evaluated cooperatives is destined.

The indicator of safety and quality of life at work, for example, was defined to indicate standards in the cooperative's working environment, through information on identification and organization of the work process, use of personal protective equipment and awareness of the importance of using these. The infrastructure is represented by physical aspects necessary or mandatory for the cooperative to function fully, such as:

paving and covering the waste sorting site, formal water and electricity services. And, finally, the disposal of tailings was also considered, which can represent an environmental problem after sorting, being one of the greatest difficulties encountered by cooperatives for environmental adequacy.

How the indicators were obtained, as well as the factor considered for the index, are shown in Table 10.

**Table 10.** Ecological sustainability indicators of recyclable material pickers' cooperatives

Indicators	Calculation Form	Factor
Safety and quality of life at work	(Physical organization of the cooperative <sup>1</sup> + Use of personal protective equipment <sup>2</sup> + Resistance to the use of personal protective equipment <sup>3</sup> ) divided by three	0.33
Infrastructure	(Workplace structure of the cooperative headquarters <sup>4</sup> + Public Services Regularized by Responsible Company <sup>5</sup> + Paving the workplace <sup>6</sup> + Receipt / Collection of Waste with motorized vehicles <sup>3</sup> + Average age of vehicles <sup>7</sup> ) divided by five	0.33
Tailings Destination	Proper destination of the waste generated in the cooperative is carried out <sup>3</sup>	0.33

<sup>1</sup>Sum Areas defined physically by means of marking / visual identification (YES = 10; NO = 0) divide by seven. The areas are Unloading / storage, Sorting, Storage, Bales Stock, Truck transit area, Cafeteria / Bathrooms, Office;

<sup>2</sup>Sum of the types of PPE's (Personal protective equipment) used by the members (YES = 10 / NO = 0) divided by nine. The PPE's are Uniforms, Gloves, Glasses, Boots, Ear protector, Mask, Helmet, Apron, Rain cap;

<sup>3</sup>If YES = 10 / NO = 0;

<sup>4</sup>If Adapted Land = 3, Adapted Construction = 6, Shed = 10;

<sup>5</sup>Sum of Regularized Public Services (YES = 10 / NO = 0) divided by seven because it are Electricity, Water, Sewage, Waste Collection, Fixed Telephony, Internet and if there is no regularized service;

<sup>6</sup>If YES = 10, NO = 0, PARTIALLY = 5;

<sup>7</sup>Vehicles with: more than 10 years = 10, less than 10 years = 0, do not have = 0.

Applying the calculation methods indicated in Table 10 to obtain the 'Ecological Indicators'. The indicators and Ecological Index presented in Table 11 were obtained.

Analyzing the Ecological Index, it appears that only 25% of the cooperatives reached an index equal to or greater than 6 (Satisfactory +).

The indicator 'Adequate destination of tailings' presented the worst performance among the other ecological indicators, pointing to an emergency demand for action plans that promote public or private partnerships to collect and dispose of this waste, or even impose the acceptance of contracts between cooperatives and companies collection

**Table 11.** Results obtained in the analysis of ecological indicators of the cooperatives of Jardim Gramacho

CRMC	Safety and quality of life at work	Infrastructure	Tailings destination	ELDI
1	8	6	0	5
2	4	1	10	5
3	3	1	0	2
4	3	1	0	1
5	9	5	0	4
6	6	8	0	4
7	8	9	10	9
8	7	8	10	8
9	7	2	10	6
10	8	6	0	5
11	2	4	0	2
12	7	5	0	4

or receipt of residues that enable the proper disposal of the waste, or even analysis for converting the waste into waste and reintroducing it into the production scale. The transformation of tailings into an energy source is also an interesting alternative, which is already being studied by some researchers, such as Mala'ák, Velebil, and Bradna (2018).

Action plans in this sense improve the 'Ecological Index', not only of the cooperative but also of the surrounding community, reducing the number of clandestine dumps in the Jardim Gramacho neighborhood. The 15 indicators distributed in the four proposed Indices are similar to the matrix of Sustainability Indicators of Waste Pickers Organizations proposed by Besen (2011). Despite making use of different construction and validation methodologies, the indicators, for the most part, address the same theme of self-management, formalization, quality of life at work and efficiency. However, the differential of the Matrix of sustainability indicators for recyclable materials Cooperatives proposed here is in the organization of the indexes of the different dimensions of sustainability that can be used and interpreted by the pickers themselves as a way of monitoring activities.

It is possible to analyze, jointly or individually, the results, allowing the assessment of which indicators need improvement. This does not occur in the work of Besen (2011) in which the matrix of indicators was made for public policies and thus the assessment is joint. Thus, the cooperatives do not have the autonomy to evaluate the results when using this matrix, depending on the opinion of those responsible.

This flexibility in the communication of indicators and indices enables and encourages the creation of Networks and Federations of Cooperatives and facilitates the macro analysis necessary for public administration. With the same matrix of indicators, it is possible to create different types of action plans with an internal origin, starting from the cooperatives themselves, and creating and monitoring municipal public policies.

The indicators organized in different dimensions of sustainability facilitate the understanding and analysis of positive and negative impacts of different types of projects since they indicate the good or bad performance of each indicator, that is, the project or action plan can emphasize only in the aspect to be improved. And with the sustainability circles, it is possible to compare different action plans that impact the same dimension of sustainability, or even create and monitor action plans that generate impacts in more than one aspect of the sustainability circle.

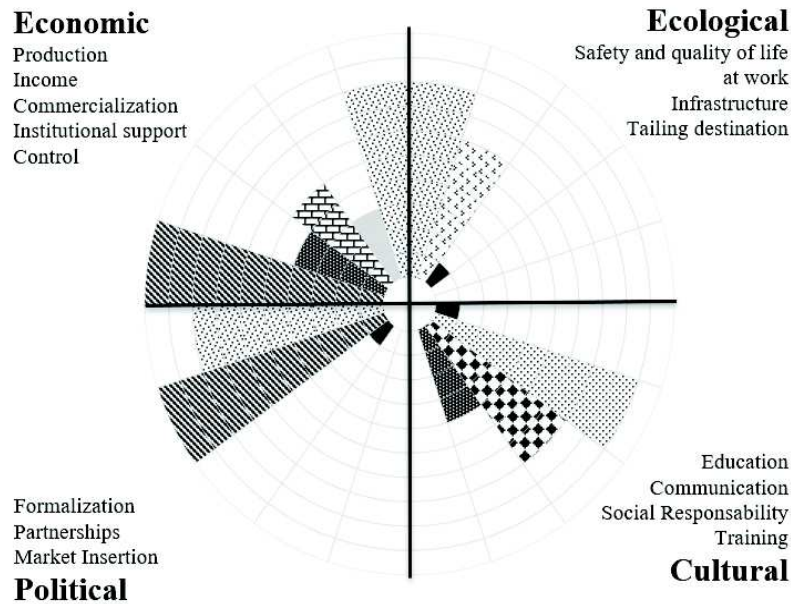
In the sixth stage were validate the sustainability indicators.

The data represented in the Cooperative Cooperative Ecological Sustainability Circle are presented in Fig. 2. When analyzing the results of the Cooperative Ecological Social Sustainability Circle, it is possible to verify that the aspect with the worst result is Ecological, where the set of indicators varied the gradation between 8 (good) in Safety and Quality of life at work and 1 (critical) in Waste disposal. In other aspects of sustainability, there was at least 1 indicator with a gradation better than 8 (good), as in the case of the Economic aspect, where the Control indicator had a maximum gradation of 10 (ideal).

The figure facilitates the visualization of the main demands of Cooper Ecológica. From this, it is possible to create 'Action Plans' according to the aspects of the worst performance or even the individual indicators. The ideal would be to create 'Action Plans' that generate positive impacts on different indicators simultaneously. A suggestion for an 'Action Plan' with separate indicators would be regular



(supplementary) and technical training courses for members, thus generating positive impacts on the Indicator of Education and Market Insertion, which are graded 1.0 (critical).



Legend: Ideal; Vibrant ; Good; High satisfaction; Satisfactory +; Satisfactory; Satisfactory -; High dissatisfaction; Bad; Critical

**Figure 2.** Cooperative Ecological Social Sustainability Circle.

In the case of the Public Power, be it municipal or state, it would be interesting to see the demands and strengths or potentialities of the ‘Circle of Social Sustainability of Cooperatives’, contemplating all that could be done, or by neighborhood, depending on the number of cooperatives in the region to be served. analyzed.

The ‘Sustainability Indexes’ of the 12 CMR Cooperatives interviewed were presented in Fig. 3. Like the individual Sustainability Circle, the indexes of the cooperative set were also divided into four quadrants, each representing an aspect of sustainability. Each quadrant is subdivided into 12 slices, each representing a cooperative. The slice radius represents the gradation of the sustainability index according to the legend in Fig. 3. The slices represent the sustainability indexes of each cooperative, therefore, each cooperative was represented by four slices, one per quadrant. The share of each cooperative is represented in the same order as the list of cooperatives arranged just below the quadrant title. Always read from top to bottom, according to the programmed order of the quadrant. It is worth mentioning that the number of slices per quadrant will always be proportional, with the cooperative always being represented by four indexes.

### Economic

- Cooperative 1
- Cooperative 2
- Cooperative 3
- Cooperative 4
- Cooperative 5
- Cooperative 6
- Cooperative 7
- Cooperative 8
- Cooperative 9
- Cooperative 11
- Cooperative 12

- Cooperative 1
- Cooperative 2
- Cooperative 3
- Cooperative 4
- Cooperative 5
- Cooperative 6
- Cooperative 7
- Cooperative 8
- Cooperative 9
- Cooperative 10
- Cooperative 11
- Cooperative 12

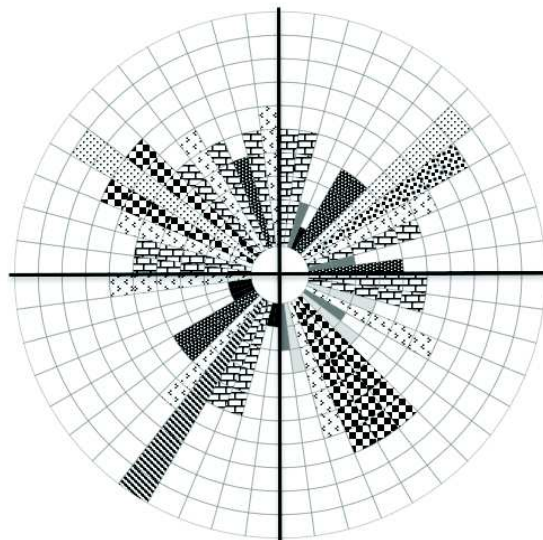
### Political

### Ecological

- Cooperative 1
- Cooperative 2
- Cooperative 3
- Cooperative 4
- Cooperative 5
- Cooperative 6
- Cooperative 7
- Cooperative 8
- Cooperative 9
- Cooperative 10
- Cooperative 11
- Cooperative 12

- Cooperative 1
- Cooperative 2
- Cooperative 3
- Cooperative 4
- Cooperative 5
- Cooperative 6
- Cooperative 7
- Cooperative 8
- Cooperative 9
- Cooperative 10
- Cooperative 11
- Cooperative 12

### Cultural



Legend: Ideal; Vibrant ; Good; High satisfaction; Satisfactory +; Satisfactory; Satisfactory -; High dissatisfaction; Bad; Critical

**Figure 3.** Sustainability indexes of the 12 cooperatives evaluated.

By jointly analyzing the four aspects in Fig. 3 it is possible to verify that the political dimension has the worst result. Despite the cooperative 9 obtaining the maximum index 10 (ideal), the average among the 12 cooperatives is only 4 (satisfactory -), and five cooperatives obtained the worst gradation in this aspect: 1 (critical). The indices of ecological and cultural dimension have a graded average, with most of the values as satisfactory (value 5). The economic dimension indexes had the best average performance: 6 (satisfactory +). This joint analysis is of great value for the municipal government and the class movements, which can assess the main demands of the group of cooperatives in order to facilitate the understanding and analysis of stakeholders involved. In the case of the cooperatives in the Jardim Gramacho neighborhood, through the analysis of the indices, programs are recommended that encourage the formalization of cooperatives, facilitate the hiring of cooperatives in the Municipal Selective Collection program or even promote the creation of laws that encourage large generators to hire cooperatives in companies' waste management.

The 'Indicator Matrix' can function as a tool to assist in internal and external planning. The use of a tool that allows the analysis of the results and the creation of action plans by the entrepreneurs themselves is of vital importance, especially for such an informal sector and with organizational difficulties, such as recycling in Brazil. The developed matrix presents several results in a simple and easy to understand way, being able to be replicated to other locations, as well as to other types of enterprises.

The presentation of the 'Circle of Sustainability of Recyclable Material Pickers' Cooperatives' demonstrated that it is an instrument of easy analysis and handling that can function as the institution's self-analysis tool and short, medium and long term planning, depending on the goals established in assembly. Besides, such a tool can also be used to provide data to the government, which needs information from the set of CMR Cooperatives to create public policies geared to the category. This tool presents in which dimension that group of cooperatives needs more attention, that is, dimensions of sustainability with a higher incidence of lower rated indexes.

In addition to the panorama by dimension, it is possible to verify the performance of the set of CMR Cooperatives considering the different aspects of sustainability, without having extensive tables, on the contrary, an interesting tool for decision making and of a transparent nature. At the same time that it presents the individual sustainability indices, it also provides information about the group. In addition to the practical nature, the 'Matrix of Indicators' presents itself as a suggestion of data standardization for the form of the Annual List of Information of Work Cooperatives (RAICT). The 'Matrix of Indicators', the 'Circle and Sustainability' and the 'Sustainability Indices' proposed would comply with the principles of Law number 12890 (Brasil, 2012).

## CONCLUSIONS

The 'Matrix of Sustainability Indicators' was composed for 15 indicators, being organized into indexes in different dimensions: cultural, political, ecological and economic. The indicators and indices created were organized in Sustainability Circles that allowed the correlation and easy visualization of data as a matrix of indicators. In the Sustainability Circle, the 15 indicators were presented with gradations ranging from 1.0 (critical) to 10 (ideal). When applying the matrix to all cooperatives in the Jardim Gramacho neighborhood, it was found that the political dimension had the worst result, the ecological and cultural dimension indexes presented most of the values as satisfactory (value 5) and the economic dimension indexes showed the best average performance presenting most of the values as 6, considered satisfactory (+).

The Sustainability Indicator Matrix was developed not only as a diagnostic tool, but also for monitoring, that is, using the same model and scale, it is possible to generate a history of indicators that measure the development of cooperatives in search of the ideal result, which is sustainability. It was found that the tool makes it possible to communicate the diagnosis of the collective of cooperatives in a simple way, where it is possible to verify the amplitude of performance among the cooperatives, and, at the same time, to identify in which aspect the collective of cooperatives has greater difficulty. The matrix demonstrates impartially and democratically in which aspects the collective of cooperatives needs greater investment, be it through Public Policies and Private Sector Projects.

ACKNOWLEDGEMENTS. We thank all the cooperatives that agreed to participate in the project.

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