SUSTAINABILITY INDICATORS OF MUNICIPAL SELECTIVE COLLECTION AND WASTE-PICKERS ORGANIZATIONS: CASE STUDY

Renato Ribeiro Siman[1]

Department of Environmental Engineering, Federal University of Espírito Santo.

Av. Fernando Ferrari, 514. Vitória – ES. Brazil. Zip code: 29075-910.

Cel.: +55 (27) 99752-2329

renato.siman@ufes.br

Jéssica Luiza Nogueira Zon

Department of Environmental Engineering, Federal University of Espírito Santo.

Av. Fernando Ferrari, 514. Vitória – ES. Brazil. Zip code: 29075-910.

jessicanzon@gmail.com

Wanda Maria Risso Günther

Faculty of Public Health, University of São Paulo

Av. Dr. Arnaldo, 715. São Paulo - SP. Brazil. Zip code: 01246-904

wgunther@usp.br

Gina Rizpah Besen

Energy and Environment Institute, University of São Paulo

Av. Prof. Luciano Gualberto, 1289 - Butantã, São Paulo - SP, 05508-010

rizpah@usp.br

Luciana Harue Yamane

Department of Environmental Engineering, Federal University of Espírito Santo.

Av. Fernando Ferrari, 514. Vitória – ES. Brazil. Zip code: 29075-910.

luciana.yamane@ufes.br

[1] Corresponding author

Declarations of interest: none

SUSTAINABILITY INDICATORS OF MUNICIPAL SELECTIVE COLLECTION AND WASTE-PICKERS ORGANIZATIONS: CASE STUDY

Abstract

Brazilian municipalities face several difficulties to carry out the municipal selective waste collection, while waste pickers organizations need to overcome many challenges to become competitive in the market. In order to reach the requirements of the Brazilian National Solid Waste Policy, it is necessary to know the elements that interfere in the performance of selective collection programs and recyclable material picker organizations. In this sense, this paper had as the main purpose to evaluate the sustainability of the selective waste collection programs and recyclable material picker organizations in the state of Espírito Santo, Brazil, and propose a new methodological strategy. Questionnaires were applied to municipal civil servants from 24 municipalities and managers of 23 waste pickers organizations in order to obtain data to calculate the indicators and indexes of sustainability. As a result, a methodological proposal was presented to improve their actions, which were hierarchized in degrees of temporal urgency for their implementation. The design of the actions has great potential for the improvement and development of municipal selective waste collection programs and recyclable material picker organizations towards sustainability, as well as providing sustainable solid waste management.

1. Introduction

The integration of Waste Pickers Organizations (WPO) to municipal solid waste management, mainly in low- and middle-income countries, such as Brazil [1], Chile [2], Nicarágua [3] and Malásia [4] was based on inclusive policies. In Brazil, however, the inclusion of WPO also occurs by the establishment of the National Solid Waste Policy (NSWP), established by Federal Law No. 12,305 of 2010.

Despite the evolution in solid waste management provided by the NSWP, the inclusion of waste pickers in the selective waste collection is not integrated with the waste management system. Thus, while in theory legislation supports WPOs and promotes reuse and recycling as a sustainable solution for solid waste, in practice many challenges are still to be overcome [5]. Municipalities, in general, face technical and

administrative difficulties to perform selective waste collection in a universal and efficient manner, as well as to consider WPOs as service providers [6].

Rodrigues et al. [7] emphasize that in order to meet the requirements of NSWP, it is fundamental the continuous monitoring of advances and challenges associated with the performance of the municipal selective waste collection while considering waste pickers organizations. For this, it is necessary to collect a set of information that can be used in the planning and decision-making process [8].

There is a lack of consistent information on the performance of selective waste collection considering waste pickers participation. Some studies, such as the one carried out by Ibáñez-Forés et al. [9], bringing important data on the incorporating of the informal waste collection sector to the municipal waste management system. This research is also important for the use of secondary data compiled from field data of companies in charge of the system's different life cycle stages and from the municipal authority. However, most of the times, the lack of up-to-date and computerized information for all cities and the crossing of information from the WPO perspective, among other factors, make it difficult replicate Ibáñez-Forés et al. [9] study or to carry out a more comprehensive one.

In this sense, the present study presents an innovative research with high potential representativeness involving 24 Brazilian municipal selective waste collection programs and 23 WPO, and having sustainability indicators as a study tool.

Sustainability indicators were chosen for being a current practice to evaluate the selective waste collection systems and a potential tool to support decision makers involved in the process [10]. According to Huovila et al. [11], the determination of the most suitable indicators is crucial and requires expert knowledge, since city managers might use it for target setting, performance assessment, monitoring, management, and strategic actions purposes. In addition, the evaluation through indicators contributes to identifying potential points of improvement that requires the development of actions that contribute to the evolution of the performance of selective waste collection programs and WPO towards sustainability.

From the point of view of the importance to integrate the waste pickers to the municipal selective collection system, this study determined the indices and the degree of sustainability of both, selective collection programs and the WPO, through 26 indicators and hierarchized emergency actions, categorizing which should be developed in the short, medium and long term giving high applicability to the study.

1.1 Background of selective collection sustainability indicators in Brazil

The Indicators of Sustainability of the Selective Collection (ISSC) and Indicators of Sustainability of the Picker Organizations (ISPO) used in this research were based on previous studies of by Lima [12], which focused on the fragility of the municipal selective waste collection and the WPO, consolidated by Ribeiro et al. [13]. Besen [14] started the process of constructing and validating indicators that could be used as a reference for the management, evaluation, and monitoring of municipal selective waste collection and WPO in 2011. The validation was carried out in a participatory manner with specialists in waste management and selective waste collection through the application of the Delphi Method. Regional and specific workshops were also held with WPOs, municipal technicians and non-governmental organizations (NGOs).

The indicators originally validated in 2011 have been under updates, reaching their latest version in 2017 Besen et al. [15]. In this last version, 16 ISSC and 21 ISPO are presented to evaluate the sustainability of these programs. ISSC indicators are grouped into five aspects: institutional; relations with society; efficiency; working conditions, health and safety of the worker; and financial costs. ISPO indicators are also grouped into five, but different, aspects: legal/institutional; socioeconomic; organizational; operational efficiency; and work conditions, health and safety of the worker.

The result of the application of the set of indicators, as well as the use of weights, culminates in an index that places the selective waste collection and the pickers organizations on a numerical scale that defines the degree of sustainability, being presented in detail in the topic a follow.

2. Material and methods

2.1. Study area

The research was carried out in 24 municipalities in the State of Espírito Santo (ES), Brazil, representing 30.8% in relation to the 78 municipalities of the ES, and 23 WPO located in the selected municipalities, which in turn represent 35.9% in relation to the 64 OCMR in operation in ES, as shown in Fig.1.

Figure 1 – Spatial location of the study area.
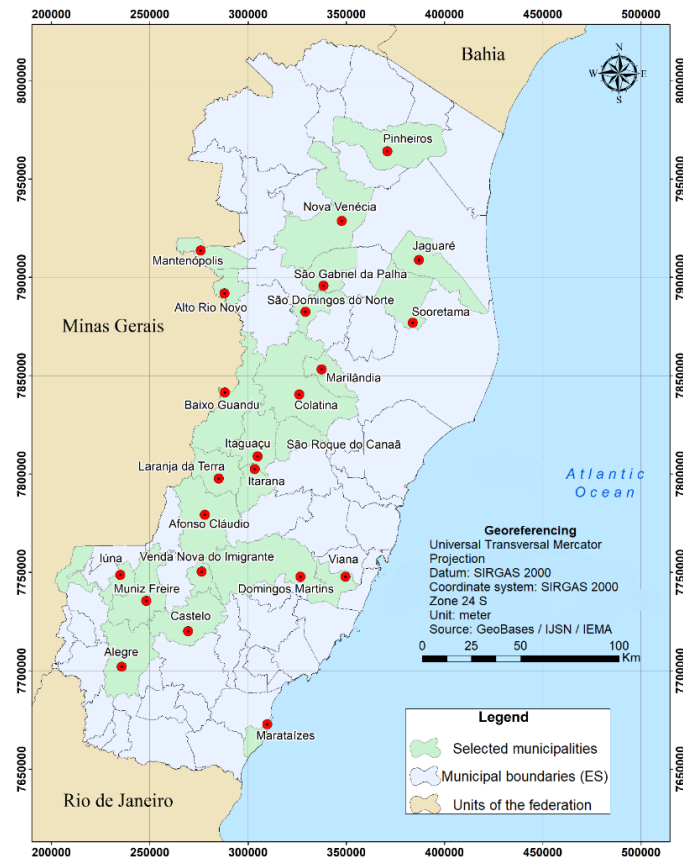
2.2. Data collection

The collection of primary data from WPO was performed through the application of two questionnaires involving open and closed questions. The questionnaire I was applied in order to collect primary data to calculate sustainability indicators and index of the selective waste collection programs. The application in the selected municipalities, occurred between the months of September and December of 2017 using the Google Forms online tool and was applied to managers responsible for the selective collection programs of each selected municipality.

In questionnaire II, data was collected through an individual interview, conducted face-to-face with the president of the organization by a multidisciplinary team during the months of May and June of 2017. It was chosen this form of inquiry since many collectors are illiterate or have a low educational level. Therefore, they may find it difficulties to read the questions.

2.3. Sustainability Indicators

Tables 1 and 2 present, respectively, the list of sustainability indicators of the Selective Collection (ISSC) and Indicators of Sustainability of the Picker Organizations (ISPO) used in this study.

Table 1 - Indicators of Sustainability of the Selective Collection (ISSC)

	ISSC	Goal	Form of measurement
ISSC 1	Legal instruments in the relation of the city with waste collection service providers	Measure the existence of legal instruments in the relationship between city halls and WPO	Existence of: service contract (VF), agreement with financial transfer (F), without financial transfer (U), no contract or agreement (FU)
ISSC 2	Population attendance	Measure the coverage that selective waste collection service achieves in terms of the number of inhabitants served.	$\dfrac{\text{Number of inhabitants served}}{\text{Total number of inhabitants}}$ (urban area of municipalities)
ISSC 3	Self-financing	Measure the economic sustainability of waste management organization.	Charge of rate or rate that: covers the cost of the service including selective collection (VF), covers the entire cost of the service (F), do not cover service costs (U), Budget only (VU)
ISSC 4	Education and dissemination	Measure the education and dissemination of actions carried out in favor of selective waste collection.	$\dfrac{\text{Number of requirements met}}{\text{Number of desirable requirements}}$
ISSC 5	Partnerships	Evaluate the diversity of partnerships articulated by municipalities in the selective waste collection	$\dfrac{\text{Number of partnerships met}}{\text{Number of desirable partnerships}}$
ISSC 6	Population adherence	Measure the effectiveness of selective collection, and the efficiency of the education/communication process, environmental, social and economic outcomes.	$\dfrac{\text{Number of households that adhere}}{\text{Total number of households assisted by selective collection}}$
ISSC 7	Recycling rate	Measure the efficiency of the selective waste collection system and the diversion of the dry waste from the landfill.	$\dfrac{\text{Weight of selective collection} - \text{Weight of }}{\text{Weight of the selective collection} + \text{regular}}$
ISSC 8	Working conditions in the collection of dry waste	Evaluate working conditions during dry waste collection.	$\dfrac{\text{Number of requirements met}}{\text{Number of desirable requirements}}$
ISSC 9	Costs of the selective waste collection service	Measure the cost of selective waste collection in relation to the amount of waste collected in the municipality.	$\dfrac{\text{Cost of the selective collection service}}{\text{Tons collected}}$
ISSC 10	Cost of selective waste collection / regular + final disposal	Measure the percentage between the cost of the selective collection and the cost of the regular collection plus to the final disposal.	$\dfrac{\text{Cost of the selective collection}}{\text{Cost of regular collection} + \text{final disposal}}$

Legend: VF – very favorable, F – favorable, U – unfavorable, VU - Very unfavorable.
Source: Adapted from Besen [15]

The asssignment of value to indicators 7, 9 and 10 presented in Tab.1 were:

- ISSC 7: $\geq 25.0\%$ (VF), 15.1% to 24.9 % (F), 5.1% to 15.0% (U) and $\leq 5{,}0\%$ (VU);

- ISSC 9: $\leq$ R$ 200.00/ton (VF), R$ 200.00/ton to R$ 350.00/ton (F), R$ 351.00/ton to R$ 500.00/ton (U)

and $\geq$ R$500.00/ton (VU);

- ISSC 10: $\leq 100\%$ (VF), 100.1% to 150% (F), 150.1% to 199.9% (U) and $\geq 200\%$ (VU).

Table 2 - Indicators of Sustainability of the Picker Organizations (ISPO)

ISPO	Goal	Form of measurement
ISPO 1 Institutional regulation	Measure compliance with documentation requirements for regularization of the organization.	$\dfrac{\text{Number of requirements met}}{\text{Number of mandatory requirements}}$
ISPO 2 Municipal legal instruments	Measure the organization's qualification in terms of legal and fiscal requirements for the provision of the selective collection service.	$\dfrac{\text{Number of requirements met}}{\text{Number of mandatory requirements}}$
ISPO 3 Quality of partnerships	Measure the contribution made possible by partners for the organization.	$\dfrac{\text{Number of partnerships effected}}{\text{Number of desirable partnerships}}$
ISPO 4 Diversification of partnerships	Measure the organization's coordination capacity, the effectiveness of establishing support networks and ability to enable financial and institutional resources.	$\dfrac{\text{Number of partnerships effected}}{\text{Number of desirable partnerships}}$
ISPO 5 Average income per member	Measure economic gains and, indirectly, the possibility of improving living conditions, health and self-esteem of the organization members.	$\dfrac{\text{Average monthly income per member}}{\text{Minimum wage}}$
ISPO 6 Gender ratio	Measure gender equity in the organization.	$\dfrac{\text{Number of requirements met}}{\text{Number of mandatory requirements}}$
ISPO 7 Self-management	Measure the effectiveness of the organization's own organizational cooperative management.	$\dfrac{\text{Number of requirements met}}{\text{Number of desirable requirements}}$
ISPO 8 Training	Measure how many waste pickers have taken professional training to carry out activities related to the functions performed within the organizations.	$\dfrac{\text{Current number of trained members}}{\text{Current number of members}}$
ISPO 9 Turnover	Measure the institutional capacity to maintain its members.	$\dfrac{\frac{\text{Number of admissions } + \text{ disconnections}}{2}}{\text{number of members}}$
ISPO 10 Diversification of activities and services	Measure the operational and organizational capacity of the entity and extend its autonomy.	$\dfrac{\text{Number of requirements met}}{\text{Number of desirable requirements}}$
ISPO 11 Recovery rate of recyclable materials	Measure the efficiency of the selective waste collection system and the diversion of the dry waste from the landfill.	$\dfrac{\text{Weight of selective collection } - \text{ Weight of tailings}}{\text{Weight of the selective collection } + \text{ regular collection}}$
ISPO 12 Screening rate	Measure the efficiency of waste separation at source and screening.	$\dfrac{\text{Weight selective collection } - \text{ Marketed weight}}{\text{Weight selective collection}}$
ISPO 13 Waste picker productivity	Measure the average efficiency of the screening work of the organization's members.	$\dfrac{\text{Amount of tonnes sorted}}{\text{Number of waste pickers}}$
ISPO 14 Working conditions in dry waste collection	Measure working conditions during dry waste collection.	$\dfrac{\text{Number of requirements met}}{\text{Number of desirable requirements}}$
ISPO 15 Environmental working conditions	Measure work environment conditions related to cleanliness, hygiene, disease vector control, infrastructure suitability, and accident prevention aspects.	$\dfrac{\text{Number of requirements made effective}}{\text{Number of desirable requirements}}$
ISPO 16 Waste picker health and safety	Measure the health and safety conditions of the waste picker at the sorting center, associated with the working conditions of the organizations and associated risks.	$\dfrac{\text{Number of requirements made effective}}{\text{Number of desirable requirements}}$

Legend: VF – very favorable, F – favorable, U – unfavorable, VU - Very unfavorable.
Source: Adapted from Besen [15]

The asssignment of value to ISPO 11 presented in Tab.2 was: ≥ 25.0% (VF), 15.1% to 24.9 % (F), 5.1% to 15.0% (U) and ≤ 5,0% (VU).

Means and frequencies were calculated to analyze the value of each of the indicators in relation to sustainability in the following intervals:

- Very unfavorable = 0 to 0.25

- Unfavorable = 0.26 to 0.50

- Favorable = 0.51 to 0.75

- Very favorable = 0.76 to 1.00

2.4. Proposition and Hierarchy of Actions

After calculating the indicators, it was possible to verify the current situation in the selective waste collection programs and waste pickers organizations. In general, these results showed that actions are needed in order to contribute to sustainable municipal development. Therefore, this study proposes the suggestion of actions using as reference the result ("very unfavorable", "unfavorable", "favorable" and "very favorable") and objective of each indicator. The actions proposed for municipal service of selective waste collection and WPO researched were hierarchized in degrees of temporal urgency for its implementation. As criteria for this hierarchy, we applied the weighting process assigned to each indicator validated by Besen [15]. Thus, the higher weight indicators are assigned with higher emergency characteristic for the actions involved in the matrix, while the lower weight indicators are proposed to be implemented in longer temporal classes (20-year time horizon). Table 3 summarizes the weights classes for each class.

Table 3 - Time horizon for the hierarchy of actions contained in the sustainability matrix

Weights of Indicators of Sustainability of the Selective Collection (ISSC) and Indicators of Sustainability of the Pickers Organizations (ISPO)	**Term**	**Time Horizon**
0.95 – 0.89	Emergency	Up to 3 years
0.88 – 0.84	Short-term	4 to 8 years
0.83 – 0.79	Mid-term	9 to 12 years
0.78 – 0.62	Long term	13 to 20 years

3. Results and discussion

3.1. Indicators of Sustainability of the Selective Collection

The average of the results obtained in the application of selective collection sustainability indicators are presented in Fig.2. The Fig.3 shows the ISSC frequency for each of the four intervals defined in the methodology. Fig. 2 and Fig. 3 show that the indicator ISSC 1 (Legal instruments in the relation of the city with service providers of the selective collection), it is observed that their average (0.78) are very favorable, indicating that most of the municipalities interviewed stated that they have a contract to provide the service. According to Hale et al. [16], "indicators themselves have an impact and they are not only representational, but they are also ways of making sense of and responding to the situations we find ourselves in". Pinheiro and Francischetto [17] affirm that valuing the work of waste pickers is fundamental for the formalization of their roles, for the integration of organizations in the recycling chain and waste management with consequent improvements in the profits of their products. According to Franca et al. [18], in Brazil, the solid waste management is performed by smaller private companies while compared to the companies responsible for public cleaning and it does not interfere in the cost structure of public cleaning and it may even increase revenue with the commercialization of waste that can be recycled.

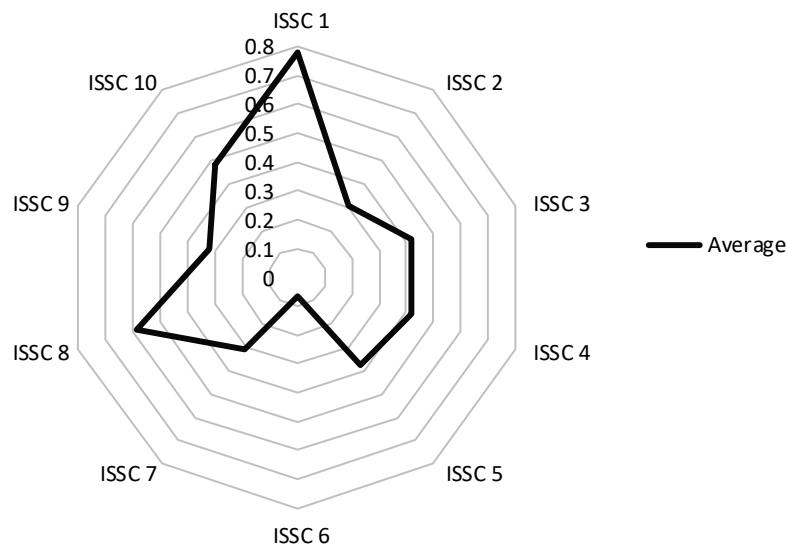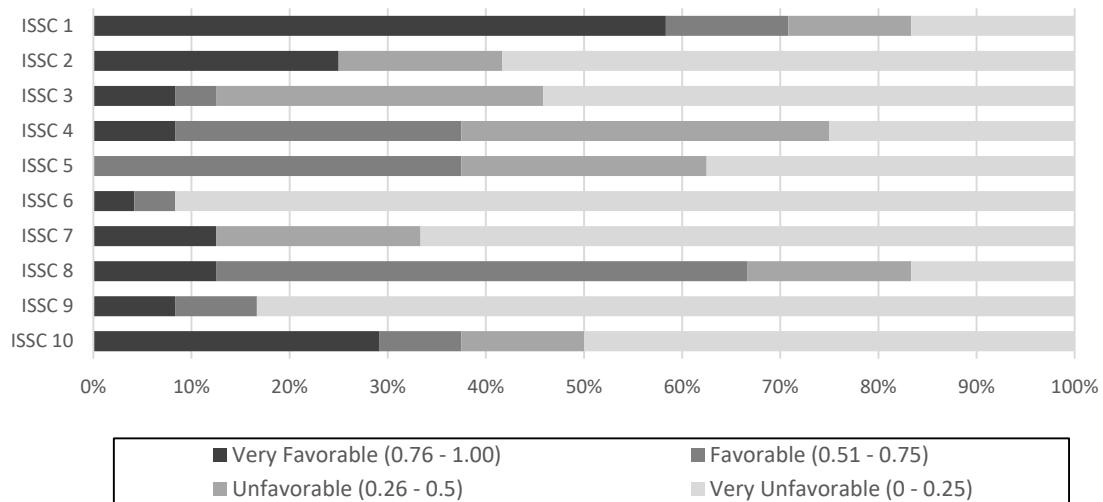**Figure 2** – Average of Indicators of Sustainability of the Selective Collection (ISSC).

Figure 3 – Frequency of Indicators of Sustainability of the Selective Collection (ISSC) in each of the intervals.

The indicator ISSC 2 (Population attendance) is of great importance since its weight (0.90) is the second largest within the set of indicators. Despite this, half of the municipalities participating in the survey did not respond to the questionnaire because they did not have real data on the number of inhabitants served by the selective collection service. Of the municipalities that responded, only in four of them, the population, has, supposedly, full access to the selective waste collection. According to the research, it was found that most of the municipalities investigated still have pilot projects of selective waste collection with low spatial impact, covering few neighborhoods. The average value of this indicator was 30% coverage. Likewise, in the Brazilians municipality of Formosa/GO, 27.17% of the population is served by selective collection, while this value may greatly vary from 2% in Salvador/BA [20] to 67.60% in the Distrito Federal [19].

Increasing the coverage of selective waste collection in municipalities would possibly lead to further diversions of recyclable materials that would be disposed in landfills, thereby contributing to lower disposal costs and extending the life of landfills. Therefore, it is an important means to reach the goal of progressive reduction of the recyclables materials disposal in landfills established by Brazilian legislation. ISSC 3 indicator (self-financing) shows that most of the municipalities (54%) participating in the survey had very unfavorable results, indicating that the form of financing is only budgeted. In the research by Besen et al. [15], the majority (65%) of the municipalities also declared that the funds for the financing of the selective waste collection came exclusively from the municipal budget. A similar conclusion was found by Reis [21]. Although the selective collection presents high costs, Campos [22] emphasizes the importance of recovering these costs for the service sustainability and the possibility of continuous

rendering through the collection of fees and tariffs. Therefore, adequate application of fees is necessary to guarantee the independence of the selective waste collection programs in relation to the municipal budget, favoring its sustainability.

Indicator ISSC 4 (Education and dissemination) has an average value of 0.42, ranking it as unfavorable, showing that municipalities still need to invest in education and dissemination campaigns in favor of selective waste collection. Besen et al. [15] and Gutberlet [5] emphasize that actions related to education and knowledge dissemination have to be permanent, comprehensive and continuous prior to sensitize the population of the importance of the waste separation in the generating source and to increase its adhesion to selective waste programs.

No municipality participating in this research presented a very favorable result related to ISSC 5 indicator (Partnerships), indicating that municipalities do not have a significant diversity of partnerships. Partnerships with the most diverse actors are indispensable since they are the ones that give support to obtain resources. In addition, the greater the diversity of partnerships, the greater the probability of expansion and continuation of selective waste collection practices [15].

The population adherence indicator (ISSC 6) shows the highest weight (0.91) within the group, thus highlighting its major importance. However, attention is drawn here to its result in which only two (8.33%) municipalities measure adherence (Colatina and Jaguaré), while the other 22 (91.67%) municipalities surveyed do not carry out any type of control of the number of households that adhere to the selective collection. Therefore, it is possible to affirm that there is a lack of methodology for measurement, as well as the lack of awareness on the major part of the municipal managers of pickers organizations.

Regarding the recycling rate indicator (ISSC 7), most municipalities (67%) presented very unfavorable results, evidencing that a large amount of recyclable waste has still been grounded. In the previous research of Besen et al. [15], most of the municipalities surveyed presented unfavorable results (63.2%). In Cardoso's study [19], recovery rates were also low in all sites studied, as well as in the Brazilian city of Salvador/BA [20].

It should also be noticed that, in general, the cities surveyed do not have data control (amount of collected waste in the selective and regular collection and quantity of tailings). Thus, it can be inferred that municipalities do not adequately control the amount of recyclable waste being diverted from the landfill.

The indicator ISSC 8 (Working conditions in the collection of dry waste), in general, presented favorable results (average equal to 0.59). However, it is observed that municipalities still need to improve the

collection conditions.

Regarding the costs of the selective collection service indicator (ISSC 9), the municipalities surveyed still have a high cost of selective waste collection per tonne, since 83% of these presented very unfavorable results (≥ R$ 500.00/ton).

Likewise, the cost of selective collection indicator (ISSC 10) is fragile, since the cost of the selective collection in 17 municipalities is ≥ 200% in relation to the cost of regular collection and final disposal (unfavorable). In the research of Besen et al. [15], the results were favorable for most municipalities and in the case of Fechine [20], the result of Salvador / BA was very favorable, both with divergent results of this research.

3.2. Indicators of Sustainability of the Pickers Organizations

The average of the results obtained in the application of the Indicators of Sustainability of the Pickers Organizations are presented in Fig.4. Fig. 5 shows the ISPO frequency for each of the four intervals defined in the methodology.

Figure 4 – Averages of Indicators of Sustainability of the Picker Organizations (ISPO).
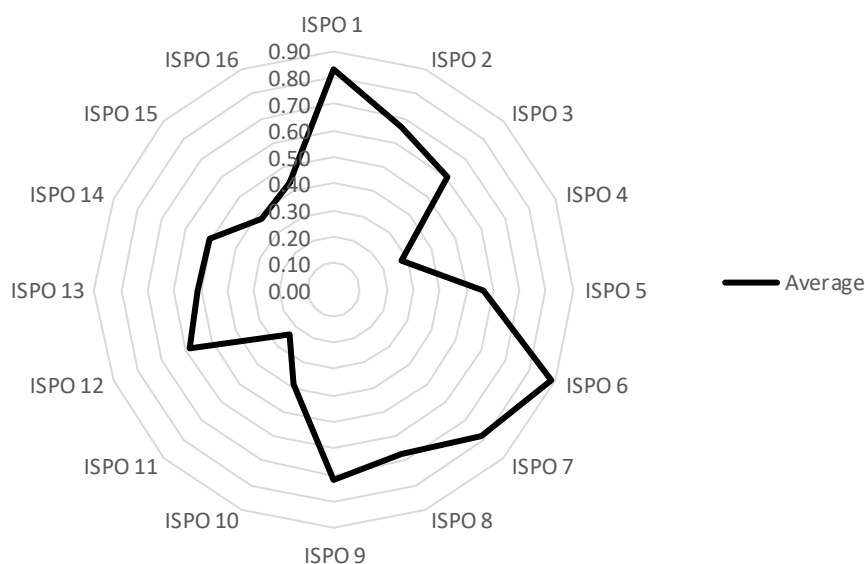
The ISPO 1 measures the regularization of the organization and obtained a very favorable average (0.83), evidencing that the majority of WPO meets the majority of requirements to remain as an association.

For the municipal legal instruments indicator (ISPO 2), the average was 0.66, that is, favorable. The mandatory requirements are expected to formalize the contracting of the WPO by the prefectures, thus offering security for contractor and servant. The prioritization of contracting the WPOs by city halls is a determination of the NSWP. For Velis et al. [23], institutional, financial, political and social issues are still present as obstacles for the inclusion of WPOs in waste management cycle.

Figure 5 - Frequency of Indicators of Sustainability of the Picker Organizations (ISPO) in each of the intervals.
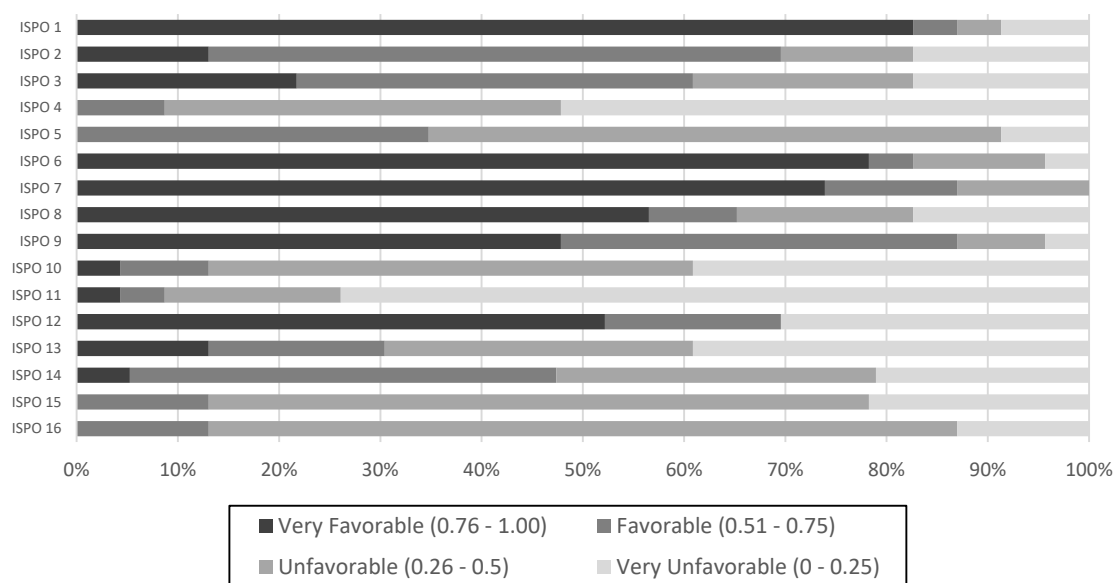
Regarding ISPO 3, in general, it presented favorable results (mean = 0.60). It is noteworthy that 20 WPO (86.96%) declared that they are contemplated by the assignment of physical space/concession of the screening shed and also the assignment of equipment and vehicles. This is due to the support that the federal, state and municipal public sector generally offer. Results obtained by Navarrete-Hernandez and Navarrete-Hernandez [2] pointed out that higher levels of local government support can improve the sustainable performance of waste-pickers in collection rates, salaries, and working conditions, contradicting predictions that there will always be a negative relation between government intervention and waste-picker performance.

For the ISPO 4, 12 WPO (52.17%) have very unfavorable results and none has partnerships with all that are considered desirable. Because of the challenges faced, the partnerships that organizations can promote

provide important support to leverage the work of the scavenger organizations [15].

The ISPO 5 indicator is the one with the highest weight (0.95) within this set of indicators. Despite this, it is observed that no WPO obtained a very favorable result. The average income was R$ 830.43, which is below the Brazilian minimum wage. The WPO income surveyed is between R$ 200 and R$ 1,300. The results found were mostly (57%), as unfavorable, between 0.5 and 1 minimum wage, based on the salary established in 2018 of R$ 954.00. The result is similar to that found by Guimarães [24], in which 57.7% of the interviewers interviewed had income between 0.5 and 1 minimum wage.

Normally, the profit of the waste pickers at the end of each month is a function of the revenue obtained from the sale of the waste, without the definition of a fixed value for each waste picker. The big problem is that, in addition to the low amount of waste that arrives at the WPO, they end up selling the waste to middlemen (intermediate agents) with lower amounts paid by the recycling industries [25]. Baptista [26] points out that middlemen and recyclers are the big beneficiaries of the activity.

ISPO 6 indicator presented better results, with a mean of 0.89 (very favorable), indicating gender equity. Fischer, Meyer, and Stephanou [27] emphasize that in the WPO, the work is done in a shared way. Women are responsible for activities such as sorting and cleaning the place, while men are designed with material transportation, loading of bags, pressuring and handling of heavy machinery. According to Guimarães [24], in relation to management, women, predominantly, are at the head of the presidency. Navarrete-Hernandez and Navarrete-Hernandez [2] also emphasize that providing access to childcare alternatives is necessary to allow the integration of female waste-pickers and reducing the occurrence of children at the workplace.

The self-management indicator (ISPO 7) presented very favorable values in 74% of the WPOs surveyed. In addition, no organization was rated as too unfavorable. The positive result evidenced in ISPO 7 may be due to the support that the organizations received from the government mainly in promoting self-management training.

In general, the training of the organization (ISPO 8) presented very favorable results, since 9 WPO (39.13%) claimed that all members were trained. These associations stated that they received training courses from some Brazilian organizations such as Aderes, Caritas, Banco do Brasil, Senai, Abiplast, Sinrecicle, and Sebrae.

ISPO 9 indicator results were favorable (0.72), indicating that, in general, there is a little turnover of the members. According to Fischer, Meyer, and Stephanou [27], the time spent by waste pickers in organizations is related to the organization's life trajectory, job opportunities and productivity.

In relation to the diversification of activities and services (ISPO 10), the analysis of the results showed that the WPO obtained an average of 0.39 (unfavorable). Velis et al. [23] and Scheinberg et al. [28] described that collectors can generally act in the collection, sorting, classification, processing, and commercialization of recyclable waste. If they carry out these activities, the service can contribute significantly to the base of the recycling chain.

In this sense, Navarrete-Hernandez and Navarrete-Hernandez [2] concluded that municipal policies should focus on increasing the capital endowments, aiming to provide access to processing machines, upgrading to motorized vehicles, and providing space for waste accumulation.

WPOs are also fragile in relation to the recovery rate of recyclable materials (ISPO 11) since their majority (74%) presented very unfavorable results. In addition to this, the result indicates that a large amount of recyclables is grounded, also indicating that the selective waste collection system is inefficient. Therefore, organizations, with the support of municipal governments, need to develop actions to reverse this situation. Verified from the perspective of public administration, the result of ISSC 7, which has the same form of measurement, described that 67% of the municipalities surveyed also presented very unfavorable results.

On the other hand, the screening rate indicator (ISPO 12) presented an average value of 0.59, that is, favorable, indicating that the waste screening in the generating source and in the sorting still demands greater efficiency, requiring environmental education actions for citizens and training for waste pickers.

The Brazilian municipality of Salvador/BA described a 3% reject rate in its WPO, thus obtaining a very favorable result, as mentioned by Fechine [20]. In the Reis study [21], in which selective waste collection programs of municipalities in the metropolitan region of São Paulo were studied without the participation of waste pickers, most of the municipalities presented favorable or very favorable results, both with a reject rate of less than 10%.

In relation to the indicator ISPO 13 (Waste picker productivity), it was verified that only three WPOs (13.04%) presented very favorable results, with values higher than three tons.month^{-1}.waste picker^{-1}, while the majority (39%) presented values very low, i.e. less than one ton.month^{-1}.waste picker^{-1}. Dutra, Yamane, and Siman [25] pointed out that in 91% of the 11 WPO of the Espírito Santo State, Brazil, surveyed by them, the waste pickers average is 0.109 tons.day^{-1}.waste picker^{-1}, while considering 20 working days in the month, corresponds to an average of 2.18 ton.month^{-1}.waste picker^{-1}.

Sembiring and Nitivattanon [29] point out that low productivity is often related to the management problems of organizations, associated with the lack of coordination of productive activities and human

resources. According to Damásio [30], the main challenge to increase the operational efficiency of the WPO is the access to higher volumes of recyclable waste, which depends on the expansion of municipal selective waste collection coverage. In general, the problems that WPO face directly affect operational efficiency.

The indicator addressing the working conditions in dry waste collection (ISPO 14) obtained a favorable average (0.51) in relation to sustainability, demonstrating that working conditions (documentation, licenses, taxes, compulsory vehicle insurance, shirts or vests with bright colors and use of individual protection equipment and working conditions that avoid accidents) evaluated for this service demand improvement actions. Likewise, when the item was measured with responses from the municipality (ISSC 9), a small difference was noticed in the indicator since the latter had an average of 0.59 (favorable). This difference is due to the fact that the question asked to calculate the ISPO 16 was answered by the servant (waste picker), while the one made for the calculation of ISSC 8 was made to the hirer (municipality). Additionally, there is also an intention to hide nonconformities when it is requested.

The results of indicators related to environmental conditions of work and waste picker health and safety (ISPO 15 and 16, respectively) are unfavorable, with a mean of 0.38 and 0.44, respectively. In this sense, Dutra, Yamane, and Siman [25] emphasize that in addition to the work in the shed requires a great physical effort, the conditions of the place are unhealthy and the waste pickers, in general, do not have the knowledge of safety procedures and hygiene of the activity.

According to Navarrete-Hernandez and Navarrete-Hernandez [2], the number of work related accidents and extensive workday can be reduced to legal levels with supportive policies.

Damásio [30] and Tirado-Soto and Zamberlan [31] affirm that the unhealthy working conditions that the collectors are exposed may be related to the capacity of the workers to deal with the activities to be developed. Without training, the likelihood of problems associated with the safety and health of waste pickers is high.

Castilhos Junior et al. [32] point out that the lack of use of individual protection equipment commonly reflects in occupational accidents in WPO. According to the authors, most accidents are cuts and scratches from sharps wastes. The use of gloves, boots, and goggles must be considered essential for the performance of the activities and is directly related to the guarantee of the minimum safety of the worker. The non-use of these items demonstrates a great fragility of the organization [33]. In this research, it was observed that most scavengers wear boots and glove. In contrast, only three WPO users (13.04%) stated that they wear glasses.

Regard sustainability indicators above discussed, Verma and Raghubanshi [34] in review about challenges and opportunities of urban sustainability indicators reported that indicators provide the necessary information for measuring environmental, economic and social progress, and help the policymakers to define priority actions and policy measures. After calculating the indicators and indices, there were listed the strategic actions for application in the monitoring and the development of selective municipal collection programs and recyclable material picker organizations towards sustainability.

3.3. Proposition and Hierarchy of Actions

For the hierarchy of actions, the weights previously defined for each indicator were used. Thus, the higher weight indicators were assigned as an emergency characteristic for the actions involved in the matrix, while the lower weight indicators assigned as longer terms. In Table 4 is presented the distribution of the terms taking into account the indicators and their respective weights.

Table 4 - Relationship between indicators ISSC and ISPO, weights and term of actions in the time horizon.

Indicators of Sustainability of the Selective Collection (ISSC) and Indicators of Sustainability of the Picker Organizations (ISPO)		Weight	Term	Time Horizon
Indicators of Sustainability of the Selective Collection	ISSC 6	0.91		
	ISSC 2	0.90	Emergency	Up to 3 years
	ISSC 7	0.89		
	ISSC 8	0.84		
	ISSC 9	0.84	Short term	4 to 8 years
	ISSC 1	0.83		
	ISSC 10	0.81		
	ISSC 3	0.80	Mid-term	9 to 12 years
	ISSC 4	0.79		
	ISSC 5	0.62	Long term	13 to 20 years
Indicators of Sustainability of the Picker Organizations	ISPO 5	0.95		
	ISPO 15	0.89	Emergency	Up to 3 years
	ISPO 11	0.89		
	ISPO 14	0.89		
	ISPO 9	0.80		
	ISPO 16	0.87		
	ISPO 1	0.84	Short term	4 to 8 years
	ISPO 2	0.84		
	ISPO 8	0.84		
	ISPO 13	0.84		
	ISPO 7	0.82	Mid-term	9 to 12 years
	ISPO 10	0.80		
	ISPO 6	0.74		
	ISPO 12	0.74	Long term	13 to 20 years
	ISPO 3	0.71		
	ISPO 4	0.66		

As already presented, the actions were proposed considering the objectives and results of each indicator, in

addition to complying with the content provided in the NSWP. Table 5 presents the hierarchy for the actions proposed for selective collection municipal programs.

Table 5 - Hierarchy of actions suggested for the selective collection municipal programs

Term	Actions suggested for the development of sustainability
Emergency	1. Create or/and improve control and registration of the scope of the selective collection in terms of inhabitants. 2. Carry out a feasibility study for care in rural areas. 3. Measure population adherence and update data record periodically. 4. Encourage the growth of population membership rates, such as granting rate or rate discounts according to the amount of recyclable waste delivered. 5. Carry out periodical opinion polls to make necessary adjustments to the selective waste collection programs. 6. To strengthen the image of the waste picker and the valorization of his work before the population. 7. Improve/maintain the quality of waste screening in the generating source and in the sorting centers by means of campaigns and continuous training. 8. Maintain/increase investments in selective waste collection chain with suitable trucks and capacity of the waste picker. 9. Increase schedule visibility (days and times) for the selective waste collection. 10. Supervise the regularity of the selective waste collection service. 11. Facilitate the segregation of recyclable dry waste into the generating source by providing appropriate containers. 12. Provide equipment that the recyclable material picker organizations do not have yet, such as presses, balances, among others. 13. Encourage the local market of recyclables to promote the commercialization of sorted waste (de-bureaucracy of municipal licensing, assignment of land in industrial zones, as well as pressuring the state government for tax relief), thus preventing them from becoming waste. 14. Measure the amount of collected waste in the selective collection. 15. Measure the amount of waste collected in the regular collection. 16. Assess the amount of tailings after sorting. 17. Periodically update the waste information system to be implemented with data on the quantity of recyclable materials collected and marketed, quantity of waste and waste collected in the regular collection.
Short term	1. Regularize documentation, licenses, vehicle property taxes and compulsory insurance of the vehicle (s) used in the selective collection. 2. Perform preventive and periodic maintenance on the vehicle (s) used in the selective waste collection. 3. Measure the amount of waste marketed. 4. Provide and enforce the use of shirts or vests with bright colors, long trousers, cap, raincoat, footwear with non-slip soles, gloves and reflective vest for nocturnal collection by waste picker. 5. Establish the individual load limit to be collected. 6. Sufficient time for the worker to collect the material without risk. 7. Supervise the requirements, in relation to the working conditions in the collection, to be established and those that already practice.
Mid-term	1. Elaborate / formalize a service agreement, complying with all the requirements for the formalization of the service. Priority should be given to contracting recyclable material picker organizations. 2. Carry out occasional and permanent campaigns: teach training activities; awareness activities for municipal employees; activities with the community; insertion into radio and TV programs; mobilizations and/or mobilizations; develop leaflets, publications, and environmental education websites; continue practicing the education and dissemination actions that the municipality already adopts. 3. Update periodically the system to be deployed of waste information with data of the monthly costs related to the selective collection. 4. Update periodically the system to be deployed with information about waste with data of the monthly costs related to the regular collection and final destination.
Long term	1. Expand the diversity of partnerships such as state and federal public sector, private sector, NGOs, Universities, neighborhood associations, among others besides those are already established.

Corroborating with the actions suggested for the selective waste collection municipal programs in the Tab. 5, the preparation of environmental education programs by the municipal governments is also pointed out by Pinhel et al. [35] and Cardoso [19]. Marshall and Farahbakhsh [36], in turn, highlight the need for population involvement for the success of the selective waste collection. In this perspective, Struk [37] points out that the discount in the annual waste rate for those who perform the selective collection,

significantly increases the adhesion rates. Marshall and Farahbakhsh [36] also emphasize the importance of incentive the effective adhesion of population on selective waste collection.

Bringhenti, Zandonade and Günther [38] and Ferreira et al. [10] also highlight the necessity for continuous assessment of selective collection systems that can contribute to decision making, corrective actions, verification of program performance, and strengthening of linkages with the target population to achieve efficient and effective. Besen et al. [15] and Cardoso [19] still emphasize that the implementation and improvement of the selective collection should be continuous and gradual.

Other actions that still need to be developed by governments are the creation of encouraging programs for recycling industries with the aim of boosting their installation in the region, as highlighted by Pinhel et al. [35]. Similarly, are still important the implantation of information platforms in order to control the amount of recyclable material collected, material commercialized, and quantity of waste, as indicated by Fei et al. [39]. The prioritization of WPOs by municipalities to carry out the selective collection through the formalization of the contract is evidenced by Pinheiro and Francischetto [17], Pinhel et al. [35] and Besen and Fracalanza [6].

Gutberlet [5] points out the collaboration of local governments in integrating pickers into selective waste collection programs, paying them for this service. Geunsilius [41] highlights their financial support for structuring WPO. In this sense, Pinhel et al. [35] and Magni and Günther [41] emphasize the need of the city hall to provide working and individual safety equipment.

Dias [42] highlights the necessity for policy interventions from various levels of government, NGOs and cooperation agencies in integrating waste pickers into solid waste management systems. Tackla, Baldam and Siman [43] point out that companies (private sector), suppliers of recyclables and supporting companies, which donate equipment and infrastructure, are also the core partners and suppliers of the WPO.

Tab.6 presents the hierarchy for the actions proposed for WPO.

Table 6 - Hierarchy of actions suggested for the recyclable material picker organizations.

Term	Actions suggested for the development of sustainability
Emergency	1. Measure the amount of collected waste in the selective collection. 2. Measure the amount of tailings after sorting. 3. Foster contract with city hall to provide service. 4. Enforce waste pickers to wear a cap, long trousers, raincoat, reflective vest for night collection, shoes with non-slip soles, shirts or vests with bright colors and a protective glove. 5. Sufficient time so that the worker can collect the material without risk to his health. 6. Establish a minimum individual load to be collected. In the sorting center: 7. Build a cook-room. 8. Perform daily cleaning of the cook-room and toilets. 9. Perform periodic control of rats, flies, cockroaches and uncomfortable odors. 10. Install adequate ventilation and lighting. 11. Adjust the coverage of the screening area. 12. Adjust the height of the table. 13. Define maximum weight limit, according to standards, to be obeyed by workers to avoid injury. 14. Implement fire prevention system and actions. 15. Implement fire alarm system. 16. Establish fire extinguisher and evacuation indicator of the area in case of fire. 17. Establish accident prevention barriers on dangerous machines. 18. Adjust the height of the seats. 19. Adequate electrical installations to avoid shock. 20. Implement control of access and movement of people. 21. Install a collective height guard (guardrail). 22. Seek support from specialized agencies, such as the Safety Engineering and Occupational Medicine Agency, municipal governments, universities, and technical institutes, for guidance in a plan of actions necessary to ensure safety. 23. Encourage resources to expand infrastructure.
Short term	1. Prepare a statute. 2. Regularize pending issues with government regulators agencies as Social Security Administration, Employee Benefits Security Administration, and Internal Revenue Service. 3. Regulate the payment of labor taxes for waste pickers. 4. Legalize the situation of the organization in the Internal Revenue Service. 5. Update waste pickers records. 6. Archive at least the last three records of meetings. 7. Carry out financial balance sheets. 8. Keep accounts transition records of the last fiscal year. 9. Provide organizational operating licenses. 10. Improve the self-management system of the organization of recyclable waste pickers. 11. Coordinate the activities carried out by the waste pickers in the organization (this action can be carried out by the president or with the support of the municipal public sector). 12. Perform periodic cleaning and hygiene at the sorting center. 13. Establish mandatory rest by load and routine of activities. 14. Ensure regular vaccination of the waste pickers in accordance with the sanitary standard. 15. Perform registration of work accidents. 16. Install visual communication in work environments as a health and safety measure. 17. Prevent injury from repetitive or inappropriate positioning. 18. Implement protective devices against physical accidents caused by machines and equipment. 19. Conduct periodic medical examinations according to the labor norm. 20. Encourage the use of equipment for individual safety. 21. Seek support to carry out training about safety and health at work in accordance with the regulatory norms.
Mid-term	1. Maintain up-to-date communication and information on marketing, expenses, external events, and meetings. 2. Keep records of expenses, discounts, and marketing. 3. Conduct periodic self-management decision meetings. 4. Provide internal rules. 5. Present transparency in the apportionment and availability of cash books, spreadsheets, and documents. 6. Carry out / promote partnerships with self-management training.
Long term	1. Search collaborative partnerships for: assignment of equipment and vehicles; assignment of physical space/construction of the sorting center; carry out education and dissemination actions for society; technical support; assignment/donation of recyclable materials; and literacy courses. 2. Expand the diversity of partnerships such as: NGOs, municipal and federal public sector, private sector, community or religious organizations and class organizations. 3. Promote equal participation of men and women in the construction of rules and procedures, including decision-making processes. 4. Promote the acceptance of female leadership. 5. Increase the diversity of activities and services, such as: participate in the collection of recyclable materials; promote environmental education for solid waste recycling; provide services to companies; and use recyclable waste for handicrafts, reuse and benefit materials.

Regarding the actions suggested in the Tab.6, it was observed that many are aimed at reducing the amount

of tailings arriving at WPO. Oliveira and Lima [44] point out that it is necessary to reduce the large amount of waste that arrives next to the recyclable materials in the WPO. In this sense, Ibáñez-Forés et al. [9] point out that it is necessary to develop awareness campaigns regarding segregation in the generating source to obtain a higher rate of recovery of recyclable materials.

The necessity for WPO members training is addressed for Marshall and Farahbakhsh [36], Fei et al. [39], Tackla et al. [43] and Poletto et al. [45] studies. Gutberlet [5] points out that the continued development of capacity in the members is essential. Amorim [46] also emphasis the need to provide literacy programs for the collectors prior to technical training.

In this same perspective, Besen and Fracalanza [6] point out the need for education and literacy programs to support the waste pickers and their organizations. Within this context, Frota [47] highlights the creation of a project of nocturnal literacy in addition to the psychosocial support for the waste pickers in organizations.

In addition, without training, the likelihood of problems with safety and health is high for waste pickers and for the environment [30, 31]. In this sense, Castilhos Junior et al. [32] emphasize the importance of training and assistance to waste pickers in order to increase the use of individual protection equipment, reducing health and safety problems related to the sorting activity.

In relation to the management of the WPO, Gunsilius et al. [40] and Velis et al. [23] emphasize the relevance of training actions, so the waste pickers can develop business skills to manage the business themselves. The advance of this action can be driven by the personal development of the associate members, accomplished by the elevation of the education level of the organization members. Gunsilius et al. [40] argue that self-management is the first step to intervene in points that unbalance organizations.

Most significant findings of Navarrete-Hernandez and Navarrete-Hernandez [2] while drawing a number of support policy recommendations to improve waste management systems point out that policies must focus themes such as: the institutionalization of the waste picker, fostering coordination with waste trucks, regularizing their collection schedules, and promoting waste separation in households prior to collection.

Finally, Franca et al. [18] reinforce that solid waste services have a cost as any other services provided and financial support of the public sector are required to having skilled personnel, appropriate equipment, adequate infrastructure, and proper maintenance.

4. Conclusions

Despite the efforts made to implement selective collection programs and to structure WPOs after the establishment of the NSWP, municipalities still face several difficulties regarding integrated solid waste management. By the present research, it was possible to verify that the municipalities of the state of Espírito Santo, Brazil, need to improve solid waste management, especially regarding selective waste collection and recycling, while through the application of the proposed methodological strategy it was possible to identify opportunities for improvement.

The results obtained in the application of the Indicators of Sustainability of the Selective Collection make it possible to understand the performance of the selective collection programs of the municipalities studied. These results indicate that, in general, municipalities still need improvement to reach the desired sustainability in their selective collection programs.

During the data collection of the selective waste collection and WPO indicators, it was possible to verify some difficulties faced by municipalities and WPO to implement self-management practices and performance evaluation with indicators. The main difficulty highlighted here was the unavailability and/or low quality of the primary data collected. This fact has a direct influence in the more comprehensive understanding of the selective collection and of the WPO studied and consequently in the implementation of the NSWP. Thus, although municipalities and WPOs have answered the questionnaires, it is necessary to create and operationalize data control systems in order to obtain more realistic results and perform continuous monitoring, as well as implement the necessary actions in an appropriate way.

According to the methodological proposal for complementation and hierarchization of actions based on the weight of the indicators, the calculation of the indicators allowed identifying the critical points that need improvement. Therefore, actions have been proposed and hierarchized following their emergency characters up to those of long terms according to the weight of the indicators.

Also, using the proposed methodological strategy, it was possible to delineate actions in a way that contributes to the improvement of the sustainability of the municipal selective waste collection programs and organizations of recyclable materials collectors. The design of the actions, as well as the results obtained, has a high potential of application in the monitoring and the development of selective waste collection programs and WPO towards sustainability.

References

[1] Fidelis, r., Colmenero, J.C.: Evaluating the performance of recycling cooperatives in their operational activities in the recycling chain. Resources, Conservation and Recycling (2018). https://doi.org/10.1016/j.resconrec.2017.12.002

[2] Navarrete-Hernandez, P., Navarrete-Hernandez, N.: Unleashing Waste-Pickers' Potential: Supporting Recycling Cooperatives in Santiago de Chile. World Development (2018). https://doi.org/10.1016/j.worlddev.2017.08.016 0305-750X/

[3] Hartmann, C.: Waste picker livelihoods and inclusive neoliberal municipal solid waste management policies: The case of the La Chureca garbage dump site in Managua, Nicaragua. Waste Management (2018). https://doi.org/10.1016/j.wasman.2017.10.008

[4] Moh, Y., Manaf, L.A.: Solid waste management transformation and future challenges of source separation and recycling practice in Malaysia. Resources, Conservation and Recycling (2017). http://dx.doi.org/10.1016/j.resconrec.2016.09.012

[5] Gutberlet, J.: More inclusive and cleaner cities with waste management co-production: Insights from participatory epistemologies and methods. Habitat International (2015). http://dx.doi.org/10.1016/j.habitatint.2014.10.004

[6] Besen, G.R., Fracalanza, A.P.: Challenges for the Sustainable Management of Municipal Solid Waste in Brazil. disP - The Planning Review (2016). https://doi.org/10.1080/02513625.2016.1195583

[7] Rodrigues, A.P., Fernandes, M.L., Rodrigues, M.F.F., Bortoluzzi, S.C., Costa, S.E.G.: Developing criteria for performance assessment in municipal solid waste management. Journal of Cleaner Production (2018). https://doi.org/10.1016/j.jclepro.2018.03.067

[8] Cifrian, E., Andres, A., Viguri, J.R.: Developing a regional environmental information system based on macro-level waste indicators. Ecological Indicators (2015). https://doi.org/10.1016/j.ecolind.2015.02.010

[9] Ibáñez-Forés, V., Nóbrega, C.C., Bovea, M.D., Silva, C.M., Virgolino, J.L.F.: Influence of implementing selective collection on municipal waste management systems in developing countries: A Brazilian case study. Resources, Conservation & Recycling (2018).

https://doi.org/10.1016/j.resconrec.2017.12.027

[10] Ferreira, F., Avelino, C., Bentes, I., Matos, C., Teixeira, C.A.: Assessment strategies for municipal selective waste collection schemes. Waste Management (2017). http://dx.doi.org/10.1016/j.wasman.2016.10.044

[11] Huovila, A. Bosch, P., Airaksinen, M.: Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when? Cities (2019). https://doi.org/10.1016/j.cities.2019.01.029

[12] Lima, R.M.S.R.: Implementation of a door-to-door selective collection program with the inclusion of waste pickers: a case study in Londrina - PR. 175 f. Dissertation (Master in Building Engineering and Sanitation), State University of Londrina, Londrina, 2006.

[13] Ribeiro, H., Jacobi, P.R., Besen, G.R., Günther, W.M.R.; Demajorovic, J., Viveiros, M.: Selective collection with social inclusion: cooperativism and sustainability. 1.ed. São Paulo: Annablume, 2009.

[14] Besen, G.R., Dias, S.M.: Sustainable public management of solid waste: use of social databases and sustainability indicators. Revista Pegada Eletrônica, Presidente Prudente, v. especial, p. 112-134, 2011.

[15] Besen, G.R., Günther, W.M.R., Ribeiro, H., Jacobi, P.R., Dias, S.M.: Management of selective waste collection and waste picker organizations: indicators and sustainability indexes. 1. Ed Plataforma digital. São Paulo: Fundação Nacional de Saúde, 2017.

[16] Hale, J., Legun, K., Campbell, H., Carolan, M.: Social sustainability indicators as performances. Geoforum (2019). https://doi.org/10.1016/j.geoforum.2019.03.008

[17] Pinheiro, P.T. Francischetto, G.P.P.: The National Policy on Solid Waste as a Mechanism for Strengthening Associations of Recyclable Material Pickers. Derecho y Cambio Social, 2016.

[18] Franca, L.S., Ribeiro, G.M., Chaves, G.L.D.: The planning of selective collection in a real-life vehicle routing problem: A case in Rio de Janeiro. Sustainable Cities and Society (2019). https://doi.org/10.1016/j.scs.2019.101488

[19] Cardoso, M.S.S.: The management of solid urban waste in RIDE-DF: the generation and the selective collection. 103 p. Dissertation (Master in Sustainable Development), Universidade de Brasília, Brasília, 2016.

[20] Fechine, R.: Sustainability indicators as tools for evaluating the selective collection programs in the city of Salvador-BA. 149 f. Dissertation (MSc in Environment, Water and Sanitation). Federal University of Bahia. Escola Politécnica, Salvador, 2014.

[21] Reis, T.C.: Municipal selective collection programs in partnership with collectors of recyclable materials in the State of São Paulo. 2015. 193 f. Dissertation (Master of Science). University of São Paulo, São Paulo, 2015.

[22] Campos, H.K.T.: Solid waste and sustainability: the role of recovery facilities. 235 f. Dissertation (Master in Sustainable Development). University of Brasília, Brasília, 2013.

[23] Velis, C.A., Wilson, D.C., Rocca, O., Smith, S.R., Mavropulos, A., Cheeseman, C.R.: An analytical framework and tool ('InteRa') for integrating the informal recycling sector in waste and resource management systems in developing countries. Waste Management & Research (2012). DOI: 10.1177/0734242X12454934

[24] Guimarães, J.P.S.: Socioeconomic profile of collectors of recyclable materials organized in cooperatives and associations of Espírito Santo. 131 f. Dissertation (Master in Sustainable Engineering and Development). Federal University of Espírito Santo, Vitória, 2017.

[25] Dutra, R.M.S., Yamane, L.H., Siman, R.R.: Influence of the expansion of the selective collection in the sorting infrastructure of waste pickers' organizations: A case study of 16 Brazilian cities. Waste Management (2018). https://doi.org/10.1016/j.wasman.2018.05.009

[26] Baptista, V.F.: The selective collection policies in the city of Rio de Janeiro: where and how are the cooperatives of collectors of recyclable materials? Revista de Administração Pública (2015). DOI: http://dx.doi.org/10.1590/0034-76121603

[27] Fischer, N.B., Meyer, D.S., Stephanou, M.: Study of the Socio-Educational Profile of the Collectors of Recyclable Materials Organized in Cooperatives, Associations and Working Groups - Final Report. Brasília: SECAD/MEC-UFRGS, 2010.

[28] Scheinberg, A., Simpson, M., Gupt, Y., Anschutz, J., Haenen, I., Tasheva, E., Gunsilius, E. (ed.): Economic Aspects of the Informal Sector in Solid Waste Management. GTZ and CWG, Eschborn, Germany, 2010

[29] Sembiring, E., Nitivattananon, V.: Sustainable solid waste management toward an inclusive society: Integration of the informal sector. Resources, Conservation and Recycling (2010). https://doi.org/10.1016/j.resconrec.2009.12.010

[30] Damásio, J.: Socioeconomic and environmental impacts of the work of waste pickers in the recycling chain - Final report. Brasília: MDS: Pangea, 2010.

[31] Tirado-Soto, M.M., Zamberlan, F.L.: Networks of recyclable material waste-picker's cooperatives: An

alternative for the solid waste management in the city of Rio de Janeiro. Waste Management (2013). doi: 10.1016/j.wasman.2012.09.025.

[32] Castilhos Júnior, A.B., Ramos, N.F., Alves, C.M., Forcellini, F.A., Graciolli, O.D.: Collectors of recyclable materials: analysis of working conditions and operational infrastructure in the South, Southeast and Northeast of Brazil. Ciência & Saúde Coletiva (2013). http://dx.doi.org/10.1590/S1413-81232013001100002.

[33] Rodrigues, H.S.: Comparative Analysis of the Secondary Cooperative RECICOOP and its Cooperatives Singular Pro-Founders: a case study based on the application of sustainability indicators. 106 f. Monography (Postgraduate in Environmental Management), Federal University of Rio de Janeiro, Rio de Janeiro, 2014.

[34] Verma, P., Raghubanshi, A.S.: Urban sustainability indicators: Challenges and opportunities. Ecological Indicators (2018). https://doi.org/10.1016/j.ecolind.2018.05.007

[35] Pinhel, J.R., Vieira, A.J.N.L., Maroni, B.C., Albuquerque, F.P., Bese, G.R., Santos, L.Y.B., Lopes, L., Cardo, M.B. (ed.): From trash to citizenship: a guide for the formation of cooperatives of recyclable waste pickers. São Paulo: Peirópolis, 2013.

[36] Marshall, R.E., Farahbakhsh, K.: Systems approaches to integrated solid waste management in developing countries. Waste Management (2013). https://doi.org/10.1016/j.wasman.2012.12.023

[37] Struk, M.: Distance and incentives matter: The separation of recyclable municipal waste. Resources, Conservation and Recycling (2017). https://doi.org/10.1016/j.resconrec.2017.01.023

[38] Bringhenti, J.R., Zandonade, E., Gunther, W.M.R.: Selection and validation of indicators for programs selective collection evaluation with social inclusion. Resources, Conservation and Recycling (2011). https://doi.org/10.1016/j.resconrec.2011.04.010

[39] Fei, F., Qu, L., Wen, Z., Xue, Y., Zhang, H.: How to integrate the informal recycling system into municipal solid waste management in developing countries: Based on a China's case in Suzhou urban area. Resources, Conservation and Recycling (2016). https://doi.org/10.1016/j.resconrec.2016.03.019

[40] Gunsilius, E., Spies, S., García-Cortes, S., Medina, M., Dias, S., Scheinberg, A., Sabru, W., Abdel-Hady, N., Santos, A.L.F., Ruiz, S.: Recovering resources, creating opportunities. Integrating the informal sector into solid waste management. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. 2011. Available in: https://www.giz.de/en/downloads/giz2011-en-recycling-partnerships-informal-sector-final-report.pdf. Acesso em: 14 abr. 2018.

[41] Magni, A.A.C., Gunther, W.M.R.: Cooperatives of waste pickers as an alternative to social exclusion and its relationship with the homeless population. Saúde e Sociedade (2014). http://dx.doi.org/10.1590/S0104-12902014000100011.

[42] Dias, S.M.: Rethinking the link between waste pickers, integrated and sustainable solid waste management and development. Tessituras: Revista de Antropologia e Arqueologia (2015). HTTP://DX.DOI.ORG/10.15210/TES.V3I1.5056

[43] Tackla, J.P., Baldam, R.L., Siman, R.R.: Occupational dysfunction in creating value proposition for recyclable material collectors organizations in Espírito Santo/Brazil. Annals of 32nd International Conference on Solid Waste Technology and Management, Filadélfia – EUA, 2017. p. 488-499

[44] Oliveira, F.G., Lima, F.P.A.: Efficiency and Solidarity in the Associations of Collectors of Recyclable Materials. Working Paper, Mulheres no Trabalho Informal Globalizando e Organizando (WIEGO), n. 22, 2012.

[45] Poletto, M., De Mori, P.R., Scheneide, V.E., Zattera, A.J.: Urban solid waste management in Caxias do Sul/Brazil: practices and challenges. Journal of Urban and Environmental Engineering (2016). doi: 10.4090/juee.2016.v10n1.050056

[46] Amorim, L.S.: Solidarity economy and collectors of recyclable materials in Salvador and Curitiba: public policies and the enunciation of identities in Brazil. Revista Avaliação de Políticas Públicas, v. 2, n. 10, 2012.

[47] Frota, A.J.A., Tassigny, M.M., Bizzaria, F.P.A., Oliveira, A.G.: Implementation of a selective collection system: legal and sustainability aspects. Revista Gestão & Sustentabilidade Ambiental (2015). http://dx.doi.org/10.19177/rgsa.v4e12015129-155