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Evaluation of the solid waste plans' quality: case study in the PCJ Watersheds

Avaliação da qualidade dos planos de resíduos sólidos: estudo de caso na região das Bacias PCJ

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ABSTRACT: Solid waste management plans are instruments determined by Brazilian national policy to propel transformations in the waste management realities in their territories. Its elaboration and implementation consider the achievement of quality levels, through continuous improvement cycles, until the full fulfillment of the objectives foreseen by the legislation. Even though it is mandatory to prepare waste plans with minimum content foreseen by law, the legal framework does not provide an instance to analyze their sufficiency or quality. In this context, the present project was developed with the objective of evaluating the quality of solid waste plans in the region of the watersheds of the Piracicaba, Capivari and Jundiaí rivers, considering the variety of planning and management attributions over the territory. The individual and consensus assessments of eight waste plans, carried out by researchers in the environmental area, were supported by adaptations of tools already qualified for that purpose in Brazilian territory and allowed the attribution of scores to each of the indicators and the qualification of these plans. Among the main results found, it is noteworthy that the national plan was assessed as of regular quality, that of the state of São Paulo as of good quality; At the municipal level, solid waste plans to have different qualities, resulting from local specificities.

Keywords: waste management; solid waste; solid waste plans; PCJ watersheds.

RESUMO: Os planos de gestão de resíduos sólidos são instrumentos previstos pela política nacional brasileira para propulsionar as transformações das realidades de gestão e manejo dos resíduos em seus territórios. Sua elaboração e implementação considera o alcance de patamares de qualidade, por meio de ciclos contínuos de

aprimoramento, até o total atendimento dos objetivos previstos pela legislação. A despeito de ser compulsória a elaboração dos planos de resíduos, com conteúdo mínimo previsto em lei, o arcabouço legal não prevê instância para análise de suficiência ou qualidade desses. Nesse contexto, o presente projeto foi desenvolvido com o objetivo de avaliar a qualidade dos planos de resíduos sólidos na região das bacias hidrográficas dos rios Piracicaba, Capivari e Jundiaí, à luz da multiplicidade de atribuições de planejamento e gestão sobre o território. As avaliações individuais e de consenso de oito planos de resíduos, realizadas por pesquisadores da área ambiental, foram subsidiadas por adaptações de ferramentas já designadas para tal fim no território brasileiro e permitiram a atribuição de notas a cada um dos indicadores e a qualificação desses planos. Dentre os principais resultados encontrados, destaca-se que o plano nacional foi avaliado como de qualidade regular, o do estado de São Paulo como de boa qualidade; e em nível municipal, os planos de resíduos sólidos possuem qualidades diversas, decorrentes das especificidades locais.

Palavras-chave: gestão de resíduos; resíduos sólidos; planos de resíduos sólidos; bacias hidrográficas PCJ.

1. Introduction

A growing concern with waste generation has been revealed as directly associated with the economic model adopted in much of the world, since the linear approach does not contribute to the establishment of actions that support sustainable development aimed at the circular economy (Cosenza *et al.*, 2020). According to Johannsen *et al.* (2022), the linear approach to production and consumption, still in force, produces waste from the extraction of raw materials to the final post -consumption disposal of goods and differs from the assumption of the circular economy, which aims to minimize waste generation, from the reintroduction of materials into the production process to minimize the final disposal and extraction of new materials, promoting a more sustainable production and supply chain. In the context of global changes, Yoo & Yi (2015) suggest that solid waste management be carried out in an integrated way, encompassing factors of public health, environment, scarcity of resources, climate change, awareness, and public participation to ensure the application of the circular economy assumptions.

According to Massoud *et al.* (2019), solid waste management is a complex set of services, traditionally entrusted to government authorities, covering various stakeholders from the public and private sectors. Still according to the authors, a solid waste management system has the main objective of mitigating the adverse impacts caused by solid waste on public health and the environment.

Waste management systems have different scopes in countries with different levels of development, and the less favored still have actions almost exclusively aimed at ensuring public health (Drimili et al., 2020). Countries such as Germany, France and some Nordics use the quantities and composition of waste to design suitable methods of managing them. In this way, they develop models and tools to rationalize their technological choices and management strategies and focus their policies on developing solid waste collection and transport programs, promoting recycling, and controlling dumping. Less developed countries still deal with

the inadequate disposal of various wastes and seek the construction or implementation of regulations that guarantee the implementation of more integrated solid waste management systems with a view to the health safety of activities (Kaza *et al.*, 2018; Drimili *et al.*, 2020).

Among the management strategies employed by developed countries are zero waste policies and the circulation of resources (closed-loop) in society, such as in South Korea (Yoo & Yi, 2015). In developing countries, such as Malaysia, Botswana, and China, and even in Spain, a developed country, the precariousness of information and the disposal of waste in inappropriate areas and in landfills are realities still experienced and, in general, associated with financial issues, technical knowledge, infrastructure and regulation on the subject. In these countries, most management efforts are restricted to urban waste (Bovea *et al.*, 2010; Moh & Manaf, 2017; He *et al.*, 2018; Mereki, 2018).

In Brazil, the integrated management of solid waste is a public attribution of the different spheres of the public power that must be carried out in an articulated way, including with the business sector. This integrated management is provided for by federal law and decree, and refers to planned and improveable systems that consider the pillars of sustainability to incorporate the 3Rs principle (reduce, reuse and recycle) and ensure the preservation of public health and environmental quality (Brasil, 2010; 2022; Fiore et al., 2018). According to Costa & Ferreira Dias (2020), one of the ways to improve waste management can be achieved through the approval and implementation of effective public policies.

Among the instruments of solid waste policy in Brazil are the management plans: national, state, micro-regional, inter-municipal and municipal. These plans, intended to guarantee the expression in the territories of the principles and objectives of the regulatory framework, must be carried out through a process of mobilization and social participation, from the perspective of cycles of continuous improvement to result in waste plans that meet a set of contents established by law (Brasil, 2010; Jabbour *et al.*, 2014; Fiore *et al.*, 2018). However, according to Maiello et al. (2018), there is a great physical and structural gap between Brazilian public policies related to the management and management of solid waste and its real and effective implementation.

Waste management subsidized by planning, planned since 2010, is still not a reality in Brazilian territory, in its different governmental spheres. At the national level, in 2012, a preliminary version of the National Solid Waste Plan (Planares) was released, but not approved and implemented. In 2020, a new draft plan was made available for public consultation and among its goals it predicted that only in 2040 all municipalities would have their plans prepared. Until 2017, according to Costa & Ferreira Dias (2020), less than half of Brazilian municipalities had an integrated waste management plan or its content was included in sanitation plans. State waste management plans were prepared for less than 70% of Brazilian states (MMA, 2020a).

The existence of documents entitled as waste plans does not mean that their content meets the minimum requirements set out in the National Solid Waste Policy (PNRS) (Oliveira & Galvão Júnior, 2016), much less that the planning has the potential

to transform territorial realities. In this context, recent efforts are being made to assess the impact of the PNRS on the national territory (Costa & Ferreira Dias, 2020); to identify requirements and propose tools for evaluating the quality of Brazilian municipal solid waste plans, with emphasis on the work of Chaves et al.(2020a; 2020b) and Fiore et al. (2018), guiding the present research, which aimed to evaluate the quality of solid waste plans applicable to the region of the Piracicaba, Capivari and Jundiaí river watersheds, namely: the national, state and municipal plans, in the light of the multiplicity of attributions of planning and management over the territory.

1.1. Characteristics of the studied region

The region of the Piracicaba, Capivari and Jundiaí river watersheds (PCJ watersheds) includes 71 municipalities that belong to the state of São Paulo and 5 municipalities from Minas Gerais, which together concentrate 7% of the national GDP and 2.7% of the Brazilian population. The PCJ's geoeconomic region has an area of approximately 15,377 km², a high degree of urbanization and a positive history of planning, due to the various actors involved in its management: inter-municipal consortium active for over thirty years; state committees (CBH - Committees of the Watersheds of the Piracicaba, Capivari and Jundiaí Rivers, being: CBH PCJ-SP, referring to the municipalities of São Paulo and CBH-PJ1-MG, referring to the municipalities of Minas Gerais); and federal (PCJ), the latter based on State (SP and MG) and National Water Resources Policies, instituted since the 1990s (São Paulo, 1991; Brasil, 1997; Minas Gerais, 1999). In these entities, representatives of municipal governments, autarchies, concessionaires, prosecutors, public and private companies, class associations and civil society participate, and planning takes place through plenary meetings, technical chambers of different themes and public hearings, among others.

Planning related to solid waste management has a greater focus of discussion with the technical sanitation chamber (CT - SA), in its working group (GT - RS), which is part of the PCJ Watersheds Committees, with the possibility of competing for financial contribution linked to federal collection and to the State Fund for Water Resources (FEHIDRO) as a program linked to a certain thematic axis through a specific public notice, which is analyzed by the technical team of the PCJ Watersheds Committees for its feasibility after delivery of all the documentation by the locality concerned (COMITÊS PCJ, 2020). In the region, the approximately 7 million inhabitants, who generate an average of 0.86 kg/inhabitant. urban solid waste, share solutions for their disposal in public and private landfills, as shown in Figure 1 (COMITÊS PCJ, 2020; IBGE, 2020).

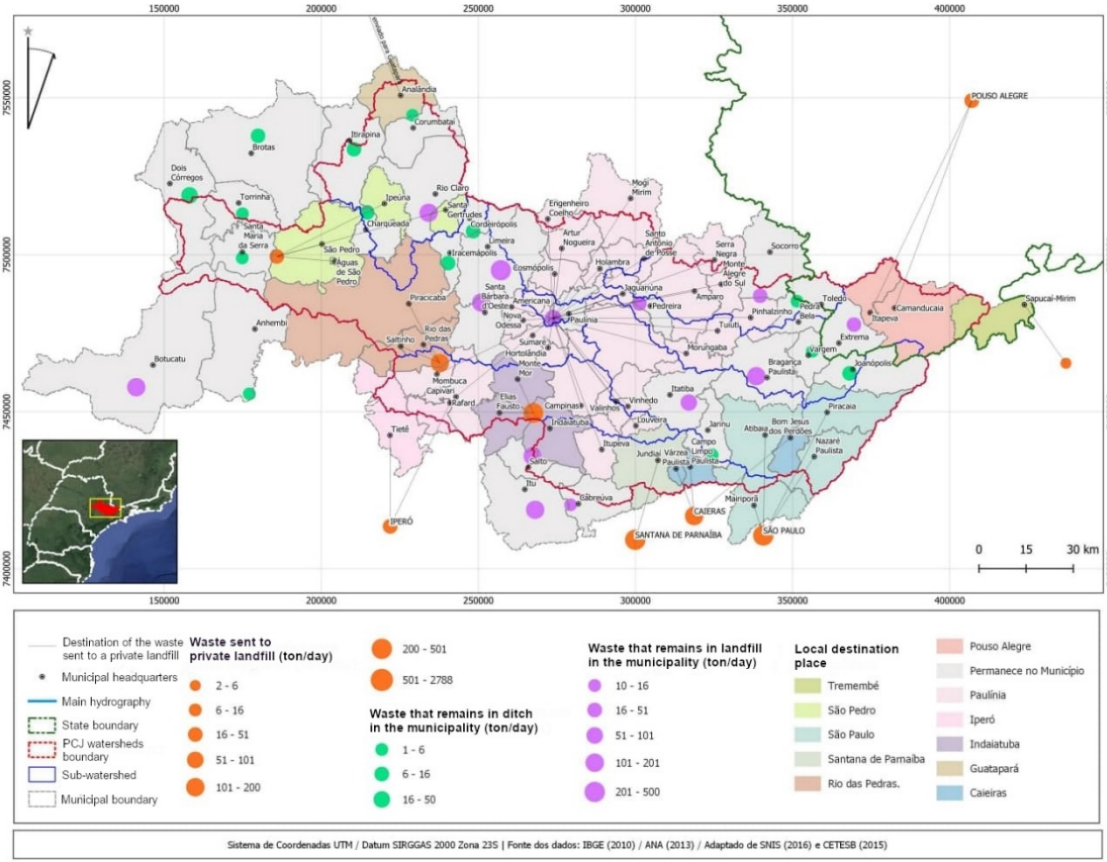

FIGURE 1 – Streams of urban solid waste (MSW) in the PCJ watersheds region.

SOURCE: Adapted from Comitês das Bacias Hidrográficas dos Rios Piracicaba, Capivari, Jundiaí (2020).

The municipalities have different characteristics, as summarized in Table 1. However, more than 90% of them declared having Municipal Plans for Integrated Management of Solid Waste (PMGIRS) or a chapter on solid waste management integrated into the Municipal Basic Sanitation Plan (PMSB). This high percentage differs from the national reality and those existing in the states of São Paulo and Minas Gerais (São Paulo, 2014; SNIS, 2018).

TABLE 1 – Characteristics of the groups of municipalities in the PCJ watersheds.

Groups of municipalities by population size	Number of municipalities in PCJ watersheds	Per capita GDP		MHDI		Generation (kg/inhabitant/day)	
		Average (R$)	DPRP	Average	DPRP	Average	DPRP
Up to 5 000	3	43474.48	38.09	0.78	9.03	0.97	35.46
From 5 001 to 10 000	12	31837.30	71.70	0.72	5.5	0.88	32.36
From 10 001 to 20 000	10	26981.05	60.04	0.72	4.51	0.87	30.16
From 20 001 to 50 000	19	65301.11	107.62	0.74	3.44	0.92	34.68
From 50 001 to 100 000	12	72772.28	73.39	0.77	3.17	0.79	23.78
From 100 001 to 500 000	19	62560.37	98.94	0.79	2.46	0.79	23.53
More than 500 000	1	51417.44	-	0.81	-	1.05	-
Total	76	54425.45	73.39	0.75	3.17	0.86	23.78

SOURCE: Adapted from IBGE, 2020; SNIS (2019, 2018, 2017, 2016, 2015).

LEGEND: DPRP: percentage relative standard deviation.

The state of São Paulo has a Solid Waste Plan (PERS/SP) since 2014 and, in 2020, a proposal to revise the document was made available for public consultation. In the state planning, waste data generated in studies produced by the PCJ consortium were considered and the relevance of the consortium's actions was considered for the proposition of inter-municipal arrangements for regionalization studies (São Paulo, 2014). According to PERS/SP, about 70% of its municipalities declared that they have PMGIRS, but that these documents have deficiencies, such as:

• Insufficient data on the characterization and disposal of solid waste;

• Failure to identify those responsible for preparing management plans;

• Failure to identify liabilities related to waste;

• Lack of details on the financial management of waste management and disposal;

• Failure to present adequate details or quantifications for proposed goals, actions and programs that, in general, were presented in an excessively generic, unrealistic way or presented only as recommendations.

In the State of Minas Gerais, where 7% of the municipalities in the PCJ Watersheds are located, the State Plan for Solid Waste is still being prepared (MMA, 2020b). In this state, the Basic Sanitation Plan, which also includes the management of solid waste, had its 1st phase started in October 2020, with an execution forecast in 18 months (SEMAD, 2020). According to the information declared by the municipalities in the state of Minas Gerais, to the SNIS (2018), about 49% of the municipalities had the PMGIRS or contained a chapter on solid waste integrated into the PMSB.

2. Methodology

This work is a descriptive research with a qualitative approach that presents a case study in the PCJ watersheds (Gil, 2002). To achieve the proposed objective, the research design was structured in three stages, as detailed in Figure 2.

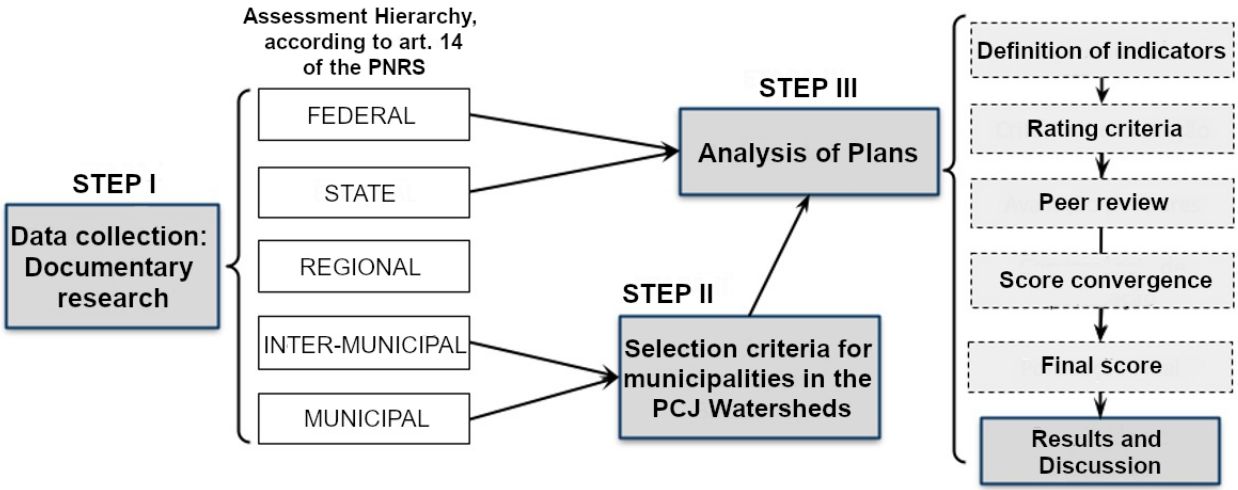

FIGURE 2 – Flowchart of the methodological scheme.
SOURCE: Own elaboration.

2.1. Criteria for data collection and analysis

Data collection, through documentary research, aimed to obtain solid waste plans at the national, state, regional and municipal levels, limited to the area covered by the PCJ Watersheds and to the documents already published in their final versions. The criteria for selecting the municipalities were designed to ensure greater representation of the territory and considered: the representativeness of the three watersheds of the PCJ's regional division; that most municipalities belong to the state of São Paulo; the size of each of the municipalities, depending on the territorial area and number of inhabitants; the possibility of municipalities with up to 20 thousand inhabitants having simplified PMGIRS. Thus, the following criteria were established for the selection of municipalities:

I – Have at least one municipality per population class, and the class adopted in this study groups the first three classes established by the Brazilian Institute of Geography and Statistics - IBGE (Table 1), that is, up to 20 thousand inhabitants, which corresponds to the municipalities with the possibility of having the simplified PMGIRS;

II – Have at least one municipality in each watershed;

III – Limit one municipality to the state of MG, as it represents less than 7% of the municipalities covered by the PCJ watersheds.

Considering the minimum content provided for in the Brazilian legal requirement and the analysis of the PMGIRS carried out in the state of São Paulo, the minimum content they must have

was used as indicators for analyzing the quality of the plans, as provided for in Federal Law No. 12,305/2010, namely: article 15th for the national plan; article 17th for the state plan; article 19th for PMGIRS or inter-municipal ones (Brasil, 2010; Fiore *et al.*, 2018). For state and municipal plans, the indicator of interrelationship with planning in other governmental spheres was also used.

As an evaluation criterion, the tool proposed by Chaves *et al.* (2020a), which considers indicators as not met or met insufficiently or sufficiently. For those served sufficiently, the conditions were also considered: good, regular or poor. The concepts of each evaluative category were adapted to simultaneously serve all governmental spheres, with the following meanings being adopted:

Attended	Existence of a minimum approach, providing for or pointing to compliance with the requirement.
Sufficient	Planning containing steps, criteria, specifications or more detailed information.
Good condition	The planning has the necessary structures to fulfill the requirement.
Regular condition	The planning leaves doubts about the fulfillment of the requirement.
Bad condition	Planning is deficient and does not guarantee compliance with the requirement.

In the individual assessment, the distribution of scores to the indicators was also supported by the proposal by Chaves *et al.* (2020a) which provides a cumulative score for each indicator, ranging from 0 to 6. For this work, the attribution of scores was performed as shown in Figure 3.

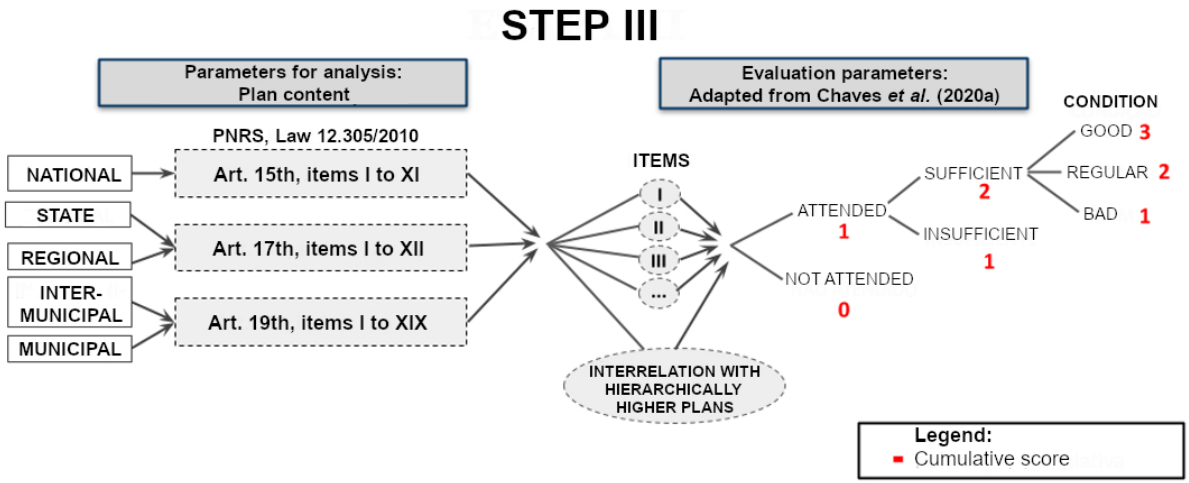

FIGURE 3 – Scoring scheme for evaluating the quality of plans.
SOURCE: Adapted from Chaves et al., 2020a; Brasil, 2010.

The analysis of each of the plans was carried out individually by three researchers from the environmental area, and the simple average and range were calculated for the set of scores from the individual assessments assigned to each indicator. The score for each indicator was calculated in two ways, depending on the amplitude value:

• Below 3: The score was the simple average, rounded to the nearest whole number.

• Equal to or greater than 3, or for attributions differing between 0 and any other value: the evaluation was resumed simultaneously among the three researchers to define a consensual score.

Based on the consensus assessment, the indicators were classified into quality levels as shown in Table 2. It is worth noting that, considering the last criterion above, all scores with a simple average of value 1 (one) were readjusted after a consensus assessment to 0 (zero) or 2 (two), so they are absent from the quality rating.

The quality of each of the waste plans was determined by the final score, in percentage, corresponding to the sum of the scores of all the plan's indicators, after reassessment, when applicable, divided by the maximum possible score. Therefore, considering the qualification of the indicators adopted and also the assumption that the minimum quality occurs from meeting the legal requirements, the plans were qualified as shown in Table 3.

TABLE 2 – Quality classification of indicators.

0	**2**	**3**	**4**	**5**	**6**
Not attended	Insufficient attended	Sufficient attended Bad	Sufficient attended Regular	Sufficient attended Good	Sufficient attended Excellent

SOURCE: Own elaboration.

TABLE 3 – Quality classification of waste plans.

Classification	**Unqualified**	**Terrible**	**Bad**	**Regular**	**Good**	**Excellent**
Score (N)	Zero score in any of the indicators[1]	$N \leq 33.3$	$33.3 > N \leq 50$	$50 > N \leq 66.67$	$66.67 > N \leq 83.33$	$N > 83.33$

[1] Except for the relationship between plans indicator – which is not a legal requirement.

SOURCE: Own elaboration.

2.2. Context of the study area

The Planares of 2012 (preliminary version) and the Solid Waste Plan of the State of São Paulo of 2014 were adopted as object of study. Waste plans were not analyzed at the regional level, because, as a result of the extinction of the body responsible for preparing these, Empresa Paulista de Desenvolvimento Metropolitano SA (EMPLASA), in 2019, by government decision, there was a suspension of discussions about Integrated Urban Development Plans (PDUIs) that would guide planning in the metropolitan regions of the State (São Paulo, 2019).

According to the established selection criteria, six locations for municipal analysis were chosen, namely: Campinas (SP), Piracicaba (SP), Bragança Paulista (SP), Camanducaia (MG), Campo Limpo Paulista (SP) and Holambra. (SP). Of these, only the municipality of Holambra (SP) has an intermunicipal plan, being a participant in the Intermunicipal Consortium in the area of Environmental Sanitation (CONSAB), and for the other territories the PMGIRS were analyzed. Table 4 summarizes the socioeconomic characteristics and waste plans of the territories studied.

TABLE 4 – Socioeconomic and plan characteristics of the territories studied.

Analysis territory	Estimated total population	HDI or MHDI	GDP per capita (R$)	Waste Generation (kg/inhabitant/day)	Year of publication of the plan	Elaboration of the plan
Brazil	211,755,692	0.755	33,593.82	1.00	2012	Mixed
Sao Paulo	46,289,33	0.783	49,498.25	1.10	2014	Own
Campinas (SP)	1,180,222	0.805	51,417.44	1.10	2012	Own
Piracicaba (SP)	387,783	0.785	65,896.34	0.90	2019	Own
Braganca Paulista (SP)	164,786	0.776	37,813.45	0.90	2015	Private
Camanducaia (MG)	21,702	0.689	25,876.92	0.70	2015	Private
Campo Limpo Paulista (SP)	82,909	0.769	25,211.06	0.80	2015	Private
Holambra (SP)	14,894	0.793	66,537.66	0.70	2013	Private

Where: Mixed - Technical Coordination of a government agency plus a Team of External Consultants; Own - Government departments; Private company.

SOURCE: Adapted from IBGE (2020); COMITÊS PCJ (2020); Waste Plans.

3. Results and discussion

The result of the individual evaluations of the plans is presented in Table 5 (detailing – Supplementary material 1). In the individual assessments, there were differences in scores in seven of the waste plans, with the national plan being the one with the highest incidence of reassessments. At the municipal level, the PMGIRS of Piracicaba was the only one whose individual assessment scores were fully convergent and, on average, 10% of the scores assigned to the indicators of the other plans had to be revised. During the consensual analysis between the evaluators, it was observed that the divergences occurred due to the subjectivity of the indicators or the level of demand of each evaluator. After assigning the consensual score or rounding the average to score each indicator, the scores were organized according to frequency and final score.

The preliminary version of Planares, from 2012, obtained a score at the limit of the range, but still classified as of fair quality. It is noteworthy that none of the indicators was evaluated as of excellent quality, as shown in Figure 4.

TABLE 5 – Scores assigned to solid waste plans.

Evaluated Plans	Average score before reassessment (%)	Indicators		Frequency of scores assigned to each plan after reassessment						Score after reassessment	
		Total	Reevaluated	Score						Total	Final (%)
				0	2	3	4	5	6		
National	66.16	11	4	0	1	2	4	4	0	44	66.67
State (SP)	77.38	14	2	0	1	0	5	4	4	66	78.57
Campinas (SP)	85.39	20	1	1	1	0	1	4	13	104	86.67
Piracicaba (SP)	90.28	20	0	0	0	1	2	6	11	107	89.17
Braganca Paulista (SP)	83.33	20	2	0	0	0	2	15	3	101	84.17
Camanducaia (MG)	60.83	20	2	0	2	5	11	2	0	73	60.83
Campo Limpo Paulista (SP)	65.28	20	2	2	0	4	7	5	2	77	64.17
Holambra (SP)	68.34	20	2	0	1	5	8	3	3	82	68.33

SOURCE: Own elaboration.

Among the weaknesses observed, it is highlighted that Planares did not present a detailed diagnosis on all classes of waste covered by the PNRS. Even considering the fact that this version was never approved, it is to be expected that high quality diagnoses are understood as basic planning elements. The greater number of indicators reevaluated for this plan was understood as a result of the high coverage of the contents specified in each topic, the presentation of only qualitative information and the lack of in-depth analysis. The lack of integration and connectivity between the proposed indicators, an issue also addressed by Chaves *et al.* (2020a; 2020b) in studies with a local emphasis, could bring a greater improvement to the documents prepared.

The solid waste plan of the state of São Paulo was evaluated as of good quality and, in addition to meeting all minimum legal content, it also established an interrelationship with the national plan, as shown in Figure 5.

FIGURE 4 – Assessment by indicators of the National Plan.
SOURCE: Own elaboration.

FIGURE 5 – Evaluation by indicators of the São Paulo State Plan.
SOURCE: Own elaboration.

Only two items, which were initially assessed as insufficient (items VII and XII), were reclassified after a consensus assessment. With respect to item VII, the plan presents the technical norms and conditions for access to state resources, but does not specify the way in which the requester can access them. For item XII, it is consensually understood that the goals and actions listed superficially inserted those responsible and forms of action of the state in relation to the direct actions carried out by the municipalities. This fact is evidenced by the absence of mention of social control in the gradual monitoring of the work stages, over time, and this item is therefore considered insufficient.

For indicators considered to be in good condition, the plan presented complete and detailed information, in line with current legislation. For the attributes considered to be of regular condition, the plan presented the basic precepts of planning, however lacking further specifications in some aspects, such as: actions, clear definition of deadlines and adoption of a perspective other than the economic one for the proposition of scenarios. For the indicators evaluated as in poor condition, the following weaknesses were verified: superficial approach; lack of qualified indicators to measure the achievement of goals in different scenarios; continuous goal setting without metric specification for improvement.

From the evaluations of the waste plans, at the municipal level, it was found that three of them obtained high scores (Figure 6). In common, the municipalities of Piracicaba, Campinas and Bragança Paulista belong to the state of São Paulo, have the highest *per capita generations* of MSW and are classified as medium or large.

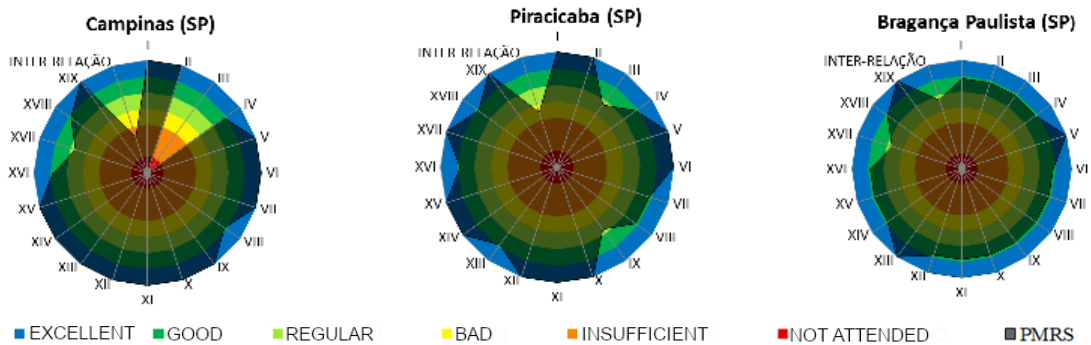

FIGURE 6 – Evaluation by indicators of the municipal plans with the highest scores.

SOURCE: Own elaboration.

The Piracicaba (SP) waste plan was evaluated as of excellent quality. This document had its revision recently approved by means of a municipal decree, was carried out by the municipality itself and demonstrated the care of the team in meeting the minimum requirements established by federal law, including highlighting the interrelationships between these contents with the development objectives. sustainable (Piracicaba, 2020). The plan incorporated flowcharts for all types of waste, often not included in simpler planning (waste of unserviceable goods, agrosilvopastoral, cemeteries, among others) and brought specifications of the concepts related to environmental education and its monitoring instruments. The point of greatest weakness identified refers to the non-binding of objectives and goals to those in force in higher spheres.

The version of the waste plan for Campinas (SP), which has the largest size and HDI among the municipalities studied, was prepared by the executive power itself in 2012. Despite the lack of revisions to date, the plan was the evaluated instrument that obtained the highest number of indicators evaluated with the optimal concept. This may be associated with the existence of a better qualified technical team in the territory with *know -how how* in public planning, as also verified by Marino *et al.* (2016). Despite this, the plan was assessed as not qualified as it did not meet item III of the PNRS. In addition, it also proved to be insufficient for the interrelationship with the national and state plans.

The waste plan for the municipality of Bragança Paulista (SP) was prepared by a private company, which was selected by the PCJ watersheds committee. The plan was rated as sufficient for all indicators evaluated, with the vast majority of indicators in good condition (83%). Such a plan presents weaknesses associated with the identification of environmental liabilities and the link with the plans carried out in other spheres of government.

The plans evaluated with the lowest scores are, in descending order, those of the municipalities of Holambra (SP), Campo Limpo Paulista (SP) and Camanducaia (MG), as shown in Figure 7. This is in line with Maiello's provisions. *et al.* (2018) on effective physical and structural distancing in Brazilian territories and can be pointed out as factors that can minimize the quality of planning. These municipalities have a population of less than 100,000 inhabitants and had their plans prepared by private companies, contracted through an external entity (linked to the watersheds committee or designated by the aggregated inter-municipal consortium).

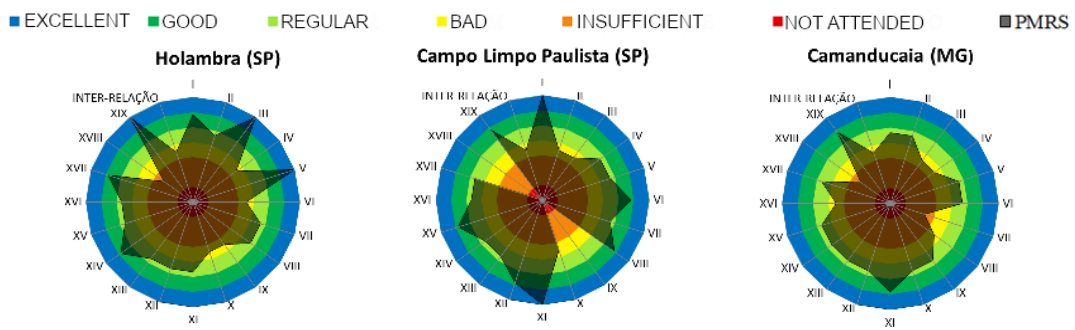

FIGURE 7 – Evaluation by indicators of the lowest score municipal plans.
SOURCE: Own elaboration.

The Municipality of Holambra (SP), belonging to the CONSAB inter-municipal consortium, had its waste plan prepared in consortium typology, with a final version published in 2014 and approved by municipal law in 2019 (CONSAB, 2014; Holambra, 2019). The Regional Plan for Integrated Management of Urban Solid Waste (PRGIRU), applicable to the municipality of Holambra, also includes six other municipalities. Much of its content was dedicated to the presentation of the diagnosis, it did not incorporate the planning that occurs in the other spheres of management and is not very specific in relation to operational performance indicators. In this plan, only 30% of the indicators were evaluated as having regular or good quality. It is noteworthy that the long period of processing of this regional plan at the local level until its approval is a negative factor that may be associated with the specificities of the appropriation of plans in broader territories or the low participation of local social actors in the elaboration of the instrument.

Since the solid waste plan of the municipality of Campo Limpo Paulista (SP) had two indicators evaluated as insufficient, namely, items IX and XVIII of article 19th of the PNRS, a revision of the instrument is necessary so that it can be qualified as PMGIRS. Despite the use of external resources, the plan was contracted directly by the municipal government and was evaluated by this study as of low quality, since among the indicators only 10% were classified as being met with good condition. Among the weaknesses of this plan, the following stand out: the lack of information considered sufficient on environmental education programs and actions aimed at the non-generation and reduction of waste, on the subject, programs essentially focused on selective collection were addressed; that the plan mentions the national and state plans, but does not link its objectives and goals to them; the need to specify goals and deadlines for achieving the objectives.

The content of the waste plan for the municipality of Camanducaia (MG) was presented in conjunction with the Municipal Basic Sanitation Plan. The PMGIRS document was presented in the same format as the PMSB and this fact made it difficult to identify the information. Despite compliance with the minimum content provided for in federal law, among the municipal plans evaluated, this was the one with the lowest number of indicators evaluated as in good condition. In this waste plan, 55% of the indicators were evaluated as having a regular condition and the other 35% as having a bad or insufficient condition. Among the weaknesses of the instrument, it is highlighted that the information is not very detailed and this converges with the notes made by Oliveira & Galvão Júnior (2016), when analyzing the inefficiency in terms of necessary strategies and programs. The two indicators with the best results refer to the forecast of the plan review and the proposition of programs and actions to include collectors in waste management.

It should be noted that the inclusion of collectors of reusable and recyclable materials can enhance the reintroduction of materials, present in MSW, into the production chain and, thus, the socioeconomic development in the territories studied. However, the waste management plans studied have not yet incorporated the concept of circular economy in depth, as advocated by Johansen *et al.* (2022) and Yoo & Yi (2015).

4. Conclusions

It is concluded that in the studied municipalities, geographically present in the PCJ watersheds, there are solid waste plans with different qualities. It was also shown that the contents of waste plans at the federal and state levels (SP) do not guide the planning of waste management at the municipal level.

Despite all the known complexity of evaluating waste plans, the commonly overlooked points are common and refer to: forecasting consortium solutions or shared with other municipalities, describing the means to be used for the control and inspection of the implementation and operationalization of waste management plans. Improvements are also required in the identification of favorable areas for the final environmentally adequate disposal of tailings and for the identification of environmental liabilities related to solid waste.

Additionally, the evaluation of the plans allowed the following inferences:

• Municipalities with higher HDI have more qualified technical staff and greater chances of properly planning waste management;

• The diagnoses of the plans need to be improved, mainly with regard to waste under the responsibility of generators and in the description of operational efficiencies;

• Low social participation occurs in cases where private companies were hired to prepare the plans;

• The periodic review of waste plans, provided for by law, provides an increase in their quality;

• The quality of the waste plan is minimized when it is presented in a document together with the sanitation plan;

• The elaboration of regional plans to substitute the local plans of solid residues can take a long time until their proposals are appropriated;

• Waste management plans can be improved by including circular economy assumptions for reverse waste.

Finally, it is understood that the methodology used in this work can be used in other territories of the country as long as it is adapted to reflect the territorial specificities. It is also expected that its results will serve as guides for assertive public policies in the PCJ watersheds, for the prior decisions of the municipalities that will still prepare their plans and for the watersheds agencies that finance this type of planning.

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