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Evaluation of the afforestation of João Pedro Menna Barreto square, Santa Maria – RS, from the expeditious method of qualitative analysis

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ABSTRACT
The implantation of trees in urban areas can have the beneficial effect of significantly improving the quality of life of the inhabitants, therefore it is essential to evaluate and conserve green areas. That said, the objectives of this work were to analyze the applicability of the Expedited Method of Qualitative Analysis in the conditions of the arboreal specimens of João Pedro Menna Barreto Square, located in the Bonfim neighborhood, Santa Maria - RS, and to characterize the vegetation regarding its current morphological characteristics, aiming at a future management of the arboreal specimens of this public open space. The evaluation of all tree specimens was performed using the Expedited Method of Qualitative Analysis based on 15 parameters. A total of 52 tree specimens constituting João Pedro Menna Barreto Square were evaluated, where it was found that 25 specimens were in poor condition, 15 in regular condition, 12 in good condition and no specimen in excellent condition, thus demonstrating the urgency of a management plan for this square.

Keywords: Afforestation, Green areas, Management.

1 INTRODUCTION

Brazilian cities face specific problems of urban areas such as increased soil sealing, high concentration of population, scarcity of leisure spaces, pollution and the risk of natural or man-made accidents consist of ineffective planning actions, which result in a reduction in the quality of life (LONDE and MENDONÇA, 2014).

To minimize these negative impacts, the emergence and expansion of cities needs to be linked to efficient planning and management, taking into account at least the proper adjustment of land use and occupation, leading to sustainable growth. The combination of these factors should minimize the negative environmental impacts of urbanization due to human activities (ALBERTIN *et. al.,* 2020).

In areas where conflicts between afforestation and other elements of the city happen, it is possible to identify spaces in which the urban morphology itself strongly prevents or inhibits afforestation, and those that result from the lack or error of planning on the part of the public power (CUNHA et al., 2020).

CEMIG (2011) comments that in addition to the choice of the species is of paramount importance a study of the environmental conditions of the place avoiding conflicts of compatibility of the specimen and the surrounding space.

Problems faced by trees in urban environments also include soil compaction and alteration due to the presence of debris, lack of water and nutrients, temperature changes, air pollution, changes in solar radiation (shading), reduced space for root and canopy growth, significant pruning (tree cutting), mechanical damage and vandalism (ARAÚJO and ARAÚJO, 2011).

According to Brazolin et al. (2014), the criteria for evaluating these trees has basically been the visual assessment and management of risk trees as part of the process of managing urban afforestation and environmental licensing in municipal governments.

However, to reduce the subjectivity of visual evaluation, evaluation protocols can be used that aim to establish a minimum script of observation and analysis by focusing the evaluation on the factors that interfere with the structural stability and risk that a tree can generate (BOBROWSK, 2016).

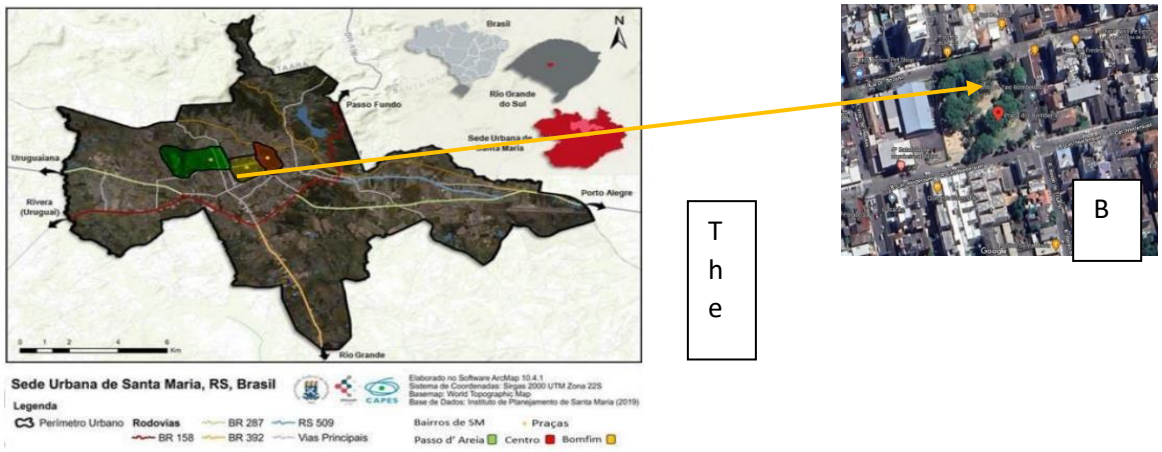
That said, the objectives of this work were to analyze the applicability of the Expedito Method of Qualitative Analysis in the conditions of the tree specimens of Praça João Pedro Menna Barreto, located in the Bonfim neighborhood, Santa Maria - RS and to characterize the vegetation as to its current morphological characteristics, aiming at a future management of the tree specimens of this public free space.

2 MATERIAL AND METHODS

2.1 AREA OF STUDY

The study site is located in Praça João Pedro Menna Barreto in the Bonfim neighborhood, municipality of Santa Maria-RS, between the streets Dr. Bozano, Barão do Triunfo and Cel. Niederauer. It has a large flow of people because it is located near the city center with local shops and bus stop for boarding the Campus line.

Figure 1: A – Map of the Location of the municipality of Santa Maria in Rio Grande do Sul; B – Location of Praça João Pedro Menna Barreto; Santa Maria – RS in Google Earth (2022).



Source: Cocco et al., 2021.

The Praça João Pedro Mena Barreto, popularly known as Praça dos Bombeiros, contains a high flow of people of different ages, and has several activities such as free markets, community actions, popular gym, playground and space for socializing animals. Its predominant use is aimed at leisure, contemplation and diverse social interactions, and its surroundings are considered mixed, residential and commercial (MELO, 2023).

2.2 EXPEDITIOUS METHOD OF QUALITATIVE ANALYSIS

The qualitative evaluation of the arboreal-shrub component of Praça João Pedro Menna Barreto, Santa Maria – RS, was developed based on a census of the arboreal vegetation, based on work carried out by Teixeira and Nunes (2019), in Praça Eufrásio Correa – Curitiba-PR, using the Expedito Method of Qualitative Analysis.

It is based on 15 parameters (Table 1) for the qualification of tree specimens as follows:

Table 1 - Categorization of note and qualification of the plant specimen evaluated in Praça João Pedro Menna Barreto; Santa Maria – RS.

Parameter	Note	Qualification
1º - Quality of the crown - analyzes the exuberance of the crown, budding rhythm, leaf coloration, epichormy and seasonality according to the phytosociological analysis.	1	Cup with the presence of dead and damaged branches due to previous pruning, accidents and weather events
	2	Cup formed by epicormic branches with adequate budding rhythm and/or in seasonal period with absence of leaves.
	3	Exuberant, robust and healthy Cup.
2º - Quality of pruning - evaluates the remnants left by previous pruning in the plant and how much these remnants influenced the life of the tree.	1	Presence of drastic pruning with residual stumps, irregular cutting line and chips.
	2	Presence of poor healing as a result of previous pruning, but with intervention and management can resolve.
	3	Anterior pruning with good healing and that the shape of the species has not been mischaracterized.
3º - Balance of the tree - analyzes the tree as a whole, comparing canopy and trunk condition as results of previous interventions.	1	Cup and trunk do not match the characteristics of the species in urban afforestation due to drastic pruning, lowering of canopy and/or release of wiring.
	2	Cup or trunk outside the expected pattern of occurrence in urban afforestation, with management and intervention can solve.
	3	Cup and trunk according to the characteristics of the species implanted in the afforestation.
4º - Contact with the wiring - analyzes the urgency and/or the need for intervention.	1	Tree specimen in contact with the wiring.
	2	Tree specimen with potential for contact with wiring.
	3	Tree specimen without possibility of contact with electrical wiring.
5º - Deterioration of the trunk - evaluates the trunk and its current situation, because in addition to being an important part for the support of the	1	Trunk has cavities and lesions that facilitate the entry of pathogens and hinder the stability of the tree.

plant as a physical structure is a place of easy contamination by pathogens.		
	2	Trunk reviled due to accidents and splinters by old pruning.
	3	Intact trunk that ensures stability for the tree.
6º - Characteristics of the bifurcation – evaluates the existence of bifurcation and the risk of falling branches.	1	Bifurcation below the DAP characterizing greater chances of falling, as it creates a point of moisture accumulation.
	2	Bifurcation above the DAP that ensures greater stability.
	3	No bifurcation that allows wide canopy and lower rate of interventions and pruning.
7º - Inclination of the trunk – evaluates the inclination of the trunk, when it exists, an analysis of the space that the plant occupies and the space of intervention, when necessary, taking into account the characteristic of the species.	1	Trunk that presents a risk of apparent fall.
	2	Trunk with acceptable slope to the site.
	3	Trunk according to species pattern
8º - Plant health – evaluates the negative impact it causes on the growth and development of the tree, the presence of pathogens.	1	Presence of pathogens such as aphid, cochineal, termite and presence of exudation.
	3	Healthy plant, without infestation.
9º - Presence of hemiparasites - evaluates the presence and proportion of hemiparasites in tree specimens.	1	> or = 75 % of the canopy occupied
	2	50% of the canopy occupied, in this case intervention is still valid
	3	< 25% of the canopy occupied which makes it easy to handle
	4	It does not present hemiparasites.
10º - Root outcropping - evaluates the outcropping of roots.	1	Presents root outcropping and/or folding
	3	Does not have root outcropping
11º - Exposed soil – evaluates the place where the specimen is planted and the lack or not of vegetation cover.	1	It presents exposed soil in the surroundings of the species, which increases the leaching of the soil, decreases the aeration and creates a superficial layer of soil decreasing the absorption of water by the same.
	2	Soil 50% covered and 50% exposed.
	3	Soil covered and protected.
12º - Compatibility with the environment - evaluates the plant as a whole interacting with the environment and its structures.	1	Tree individual is not compatible with the environment due to irregular pruning, species, size, location.
	2	Tree individual that with intervention and management becomes compatible with the environment.
	3	An arboreal individual who is compatible with the environment.
13º - Distance for buildings and buildings – evaluates the free space of root and canopy growth in relation to buildings.	1	Distance <2 meters for buildings or buildings
	2	Distance of 2 to 5 m from buildings.
	3	Distance greater than 5 m from buildings or buildings.
14º - Distance to nearest specimen – evaluates the free space of growth of the crown in relation to the nearest specimen.	1	Distance <2 m to nearest specimen
	2	Distance of 2 to 5 m to nearest specimen
	3	Distance greater than 5 m to nearest species

15º - Distance to sidewalk or curb – the free space of root growth is evaluated in relation to the boundaries of sidewalk and curb.	1	Distance <2 m to sidewalk or curb
	2	Distance of 2 to 5 m for sidewalk or curb
	3	Distance greater than 5 m for sidewalks or curbs

After the evaluation based on the parameters described above and the completion of the technical form for each specimen, the score is added and the result fits into the scoring limits for each diagnosis already previously established.

Each specimen receives a score from the lowest to the highest, which is then added and classified as excellent, good, fair or very poor (Table 2).

Table 2 - Ranking of the score and respective classification of the plant specimen evaluated in Praça João Pedro Menna Barreto; Santa Maria – RS.

SUM OF INDIVIDUAL SCORES	CLASSIFICATION
15-25	BAD
26-30	REGULAR
31-38	GOOD
39-45	EXCELLENT

3 RESULTS AND DISCUSSION

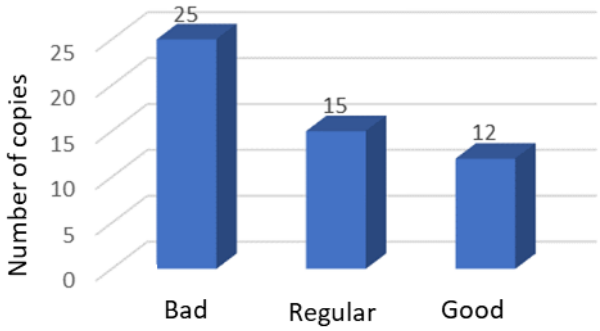
The census conducted in Praça João Pedro Menna Barreto, Santa Maria-RS, indicated the existence of 52 tree specimens, object of evaluation of the Expedito Method of Qualitative Analysis.

The first assessment is of the quality of the tree canopy, where it showed that 23 trees had a grade of 1, that is, damaged by previous pruning, dead branches or weather events.

Trees with improperly pruned pieces of branches, rotten canopies and trunks, and trees with bark and dry cover should be analyzed and methods used to mitigate these problems and reduce the risk of accidents. Only 18 trees with sufficient canopy were identified with note 3 having lush and robust canopy (figure 2). Most of the specimens evaluated presented a crown with the presence of dead branches and damaged due to previous pruning.

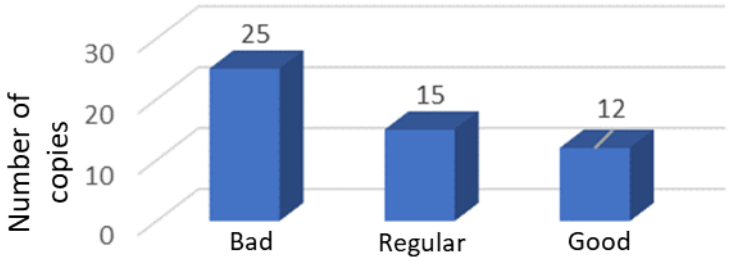
According to Falcão *et al*. (2020) it is of paramount importance that the proportion of the canopy, the volume and shape of the canopy possibly influence the achievement of benefits.

Figure 2: Distribution of the 52 tree specimens in the category related to canopy quality;



Through figure 3 it is observed that most of the trees (28), presented note 2, demonstrating that there is presence of poor healing as a result of previous pruning, but with intervention and adequate management can be resolved. The lack of maintenance and quality of pruning causes individuals to grow in disorder leading to various future problems.

Figure 3 Distribution of the 52 tree specimens in the categories related to pruning quality.



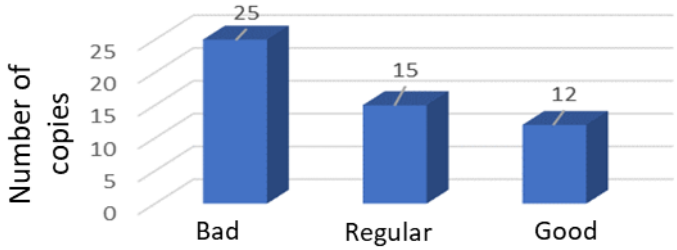
The place of implantation is of paramount importance because each species has a shape and size of canopy, which is often not adaptable to the area where it was implanted, so problems such as drastic pruning occur, which are carried out bringing damage to the tree and the emergence of fungi and bacteria and rotting.

Pruning is the most commonly used method for maintaining tree canopies. This pruning includes cleaning pruning and maintenance pruning, which is carried out when there are decaying branches, when there are phytosanitary problems, or when the branches are close to other branches. The significant removal of the canopy of trees not only compromises the natural structure of the plant, but also endangers plant health (ARAÚJO; ARAÚJO, 2016), affecting photosynthetic function and shading capacity. Therefore, before any intervention in trees, such as pruning, it should be stressed that it is necessary to know the natural development pattern of the tree (NOBRE *et al.*, 2010).

Figure 4 shows the balance in which the specimens are, and of the 52 specimens quantified in the Square, 26 were outside the pattern of occurrence in the afforestation according to note 2, but with management and intervention can solve. Most of them can be successfully managed. Represented by note 1, there were 9 trees that suffered damage and already have senescence characteristics, with difficulty in management. Note 3 is represented by 16 specimens that are compatible with the species implanted in the afforestation.

These conditions can lead to a progressive weakening of the plant, causing mismatches in the balance of the canopy and the shaft, becoming an entry point for pathogens and insects that degrade the wood (NOBRE, *et. al*., 2010).

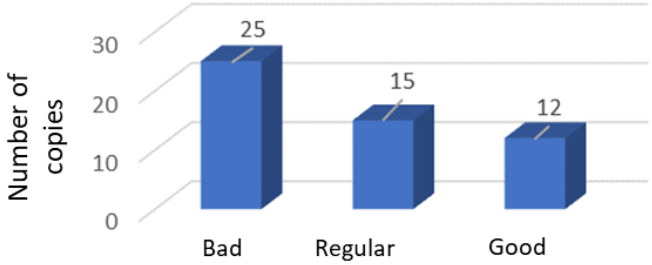
Figure 4 Distribution of the 52 tree specimens in the categories related to tree balance.



The Praça João Pedro Menna Barreto has tree specimens of advanced age and of great size. Although this situation occurs, of the 52 trees, 35 did not present the possibility of contact with the electrical network, 15 with potential contact with the wiring and 2 specimens in contact with the wiring (Figure 5).

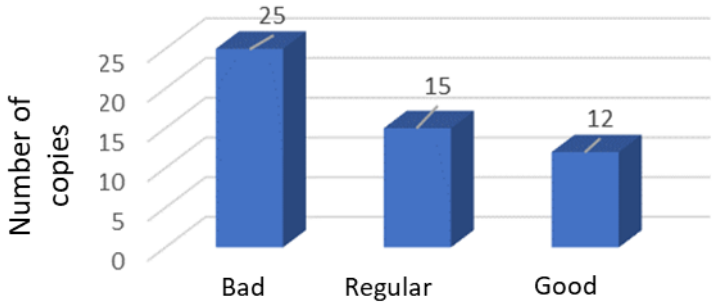
According to Ribeiro (2009) the planting of trees inadequate to the urban structure generates conflicts with urban equipment such as electrical wiring, plumbing, gutters, pavements, walls, and lampposts. These problems are very common to be visualized and cause, most of the time, an improper and harmful management to the trees.

Figure 5 Distribution of the 52 tree specimens in the category referring to the trees in contact with the wiring.



The results presented in Figure 6 demonstrated the deterioration of the trunks that allow the entry of pathogens. 25 specimens with grade 1 presented injured trunks, which shows that most of the trees have cavities and lesions. Already with the note 2 were only 3 specimens presenting trunks injured due to injuries caused by old pruning, and 24 with intact trunk, with good stability.

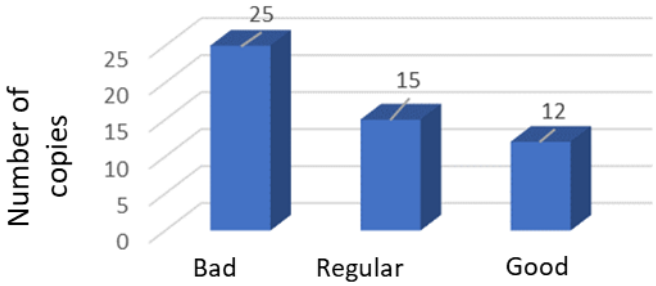
Figure 6: Distribution of the 52 tree specimens in the category referring to trees in trunk deterioration.



When the trunk has some type of opening, whether caused by mechanical friction or intense action of xylophages, in such situations the fragility of the tree occurs, whereas if it were in a natural environment this condition is usually less severe (ROSSETTI *et al*., 2010). Therefore, in fact it can be pointed out that the urban environment provides situations that intensify the creation of lesions in the trunks of trees (NOBRE *et. al.*, 2010).

Through Figure 7, it is noted that 30 tree specimens of Praça João Pedro Menna Barreto, presented grade 1, potentiating a risk of falling. The result demonstrates possible causes such as the action of the winds and the competition between the trees for space and luminosity, and 17 individuals presented grade 2 with good stability and resistance. Only 5 trees obtained grade 3 obtaining wide canopy and lower rate of interventions and pruning.

Figure 7: Distribution of the 52 tree specimens in the categories related to the characteristics of the bifurcation.



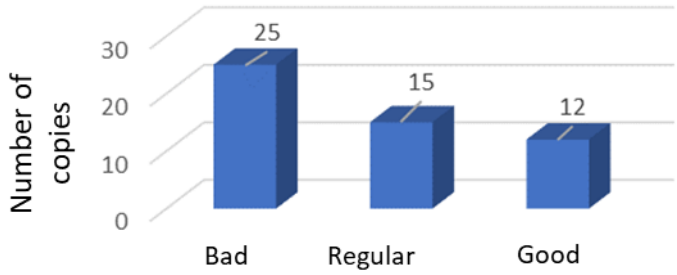
Teixeira and Marques (2022) when evaluating the Tunuca Silveira Square in São Gabriel – RS, obtained as results, regarding the height of the bifurcation, 94 specimens with bifurcation above the DAP obtaining grade 2, presenting greater stability. Of the 52 specimens that presented grade 1, it was

observed the presence of irregular pruning and the potential for falling, by creating points of moisture accumulation in the trunk.

The inventoried tree specimens obtained as results, through Figure 8, that the vast majority of them are concentrated in the condition of risk of apparent fall, with 24 specimens. Before the fall, the trunk is inclined and caused by the malformation of the canopy and improper management, causing the loss of its original structure and leading to tipping. The specimens in which the bifurcations are below the DAP, presented a greater chance of falling, by creating a point of accumulation of moisture in the trunk.

For the selection of tree species to be used for urban afforestation, it is recommended that the height of the first branching point (the insertion point of the first branch in the trunk) be less than 1.8 m due to problems related to the free movement of people, especially those with reduced mobility, (LIMA NETO *et al.,* 2010).

Figure 8: Distribution of the 52 tree specimens in the category referring to the trees and trunk slope level



The slope of the trunk is a result of competition, spacing and the quality of the seedling, this slope hinders the full development of the plant in addition to the risk of falling from the tree. In the analysis carried out by Teixeira and Nunes (2019) it was observed that 44 specimens obtained grade 3 and only 6 trees received grade 1 which is equivalent to the inclined trunk and which presents a risk of falling in Praça Eufrásio Correa (Curitiba-PR) and which was inverse to the situation of Praça João Pedro Menna Barreto.

According to Almeida and Rondon Neto (2010) the tortuosity of the trunk may come from the lack of management, problems in conducting and tutoring the plant in the stage of molting, still, the proximity of the constructions to the trees. In addition to affecting access to pedestrians and vehicles.

The results in Figure 9 show that of the 52 specimens analyzed, 28 had grade 1 presenting phytosanitary agents, which demonstrates the lack of adequate management in the fight against phytosanitary agents and 24 obtained grade 3, characterizing, apparently, as healthy plants in the middle of development.

Teixeira and Marques (2022) evaluating the afforestation of Praça Tunuca Silveira, in São Gabriel – RS, identified that 114 of the 173 specimens analyzed did not present visible pests or diseases.

Figure 9: Distribution of the 52 tree specimens in the categories related to trees and plant health.

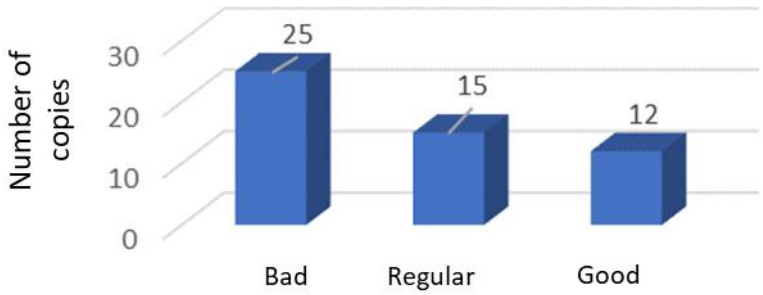
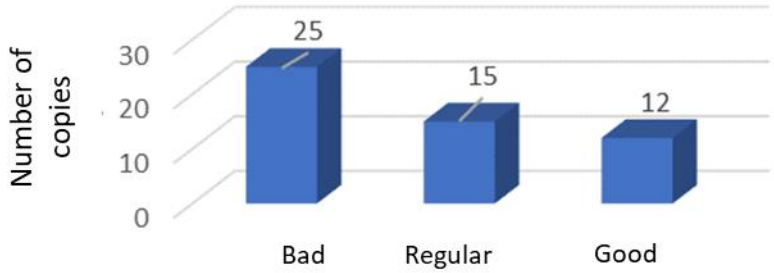


Figure 10 shows the intensity of the presence of epiphytes in the tree specimens. Of the 52 specimens analyzed, only 1 presented grade 1 with + 75% of the canopy occupied, 21 trees obtained grade 3 with less than 25% of the canopy occupied, which makes it easy to handle and 3 specimens with grade 2 with 50% of the canopy occupied.

Figure 10 - Distribution of the 52 tree specimens in the categories referring to trees with the presence of epiphytes.



The occurrence of hemiparasites is a common result in the evaluation of urban afforestation as cited by Santos et al. (2015) in a study of 25 roads of Aracaju-SE where it also presented a small value of specimens despite only 1.1% of a total of 3595 trees evaluated, infested by parasites and hemiparasites. The aforementioned authors warn of the great harmful potential that these herbs present, and that removal and constant monitoring are necessary in order to avoid these infestations, which in some years can cause the death of the host plant.

The results presented in Figure 11 showed that, in relation to the root outcropping, 41 specimens obtained a score of 1, which indicates that problems such as lifting sidewalks, folding of roots may occur, causing the tree to have loss of resistance of fixation with the soil.

According to Periotto et al., (2016), when there is space considered in agreement for the growth of the roots, there is a low possibility of problems with the pavement.

Figure 11: Distribution of the 52 tree specimens in the category referring to trees and root outcropping.

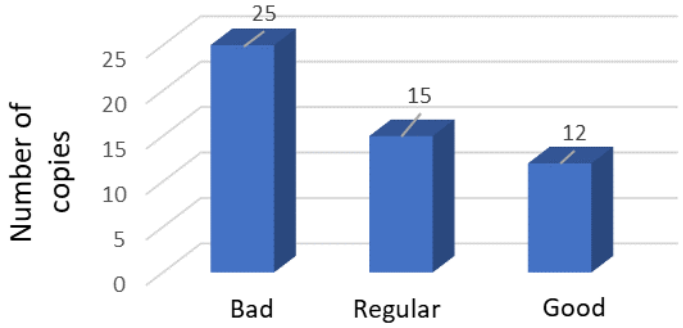
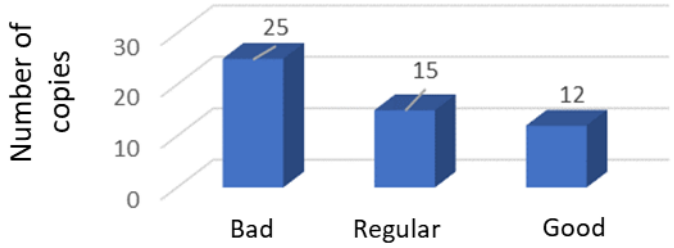


Figure 12 shows that 52 specimens presented exposed soil obtaining a score of 1. This situation provides opportunities to increase the leaching of nutrients, soil compaction and reduces water infiltration, causing limitations to the development of afforestation. None of the evaluated specimens obtained covered and protected soil.

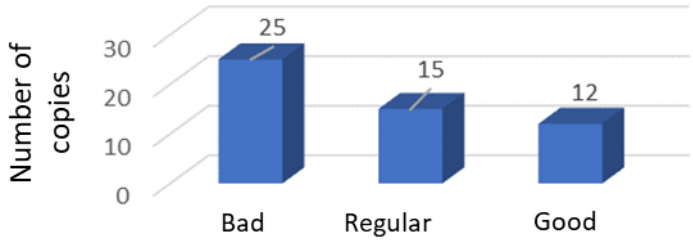
Figure 12. Distribution of the 52 tree specimens in the category referring to exposed soil.



Biondi and Althaus (2005), state that the exposed soil exhibits a more acidic pH, impairing the cycling of nutrients resulting in the modification in the activity of microorganisms, which thus negatively affect the availability of nutrients to plants.

Through figure 13, it was observed that note 2 had the largest number of specimens (24), which with intervention and appropriate management can be compatible with the environment and note 1 also presented a significant number of specimens (22) of the square that needs handling to be implanted, and only 6 copies had note 3 i.e. are in compatibility with the environment.

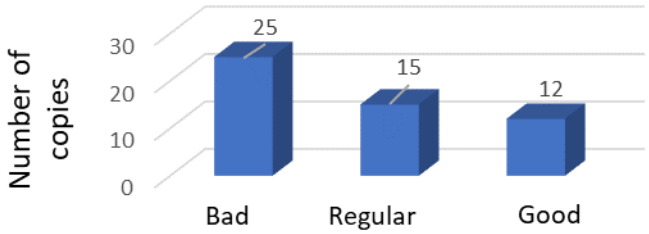
Figure 13. Distribution of the 52 tree specimens in the category referring to trees and compatibility with the environment.



According to São Paulo (2012), the management of urban trees should be restricted to pruning formation, cleaning, elimination of dead or damaged branches and emergency, only when there is a risk to the population and with potential risk to urban elements, preventing the trees from suffering drastic pruning.

Figure 14 shows the distance of the trees from the buildings and buildings. Note 3 refers to the distance of the tree greater than 5 meters from the buildings, which contains 43 specimens. In the areas with a distance of less than 2m, represented in the figure by note 1, there are only 3 specimens near the buildings and 6 trees with note 2 which is from 2m to 5m. The analysis is of paramount importance for the planning of the square.

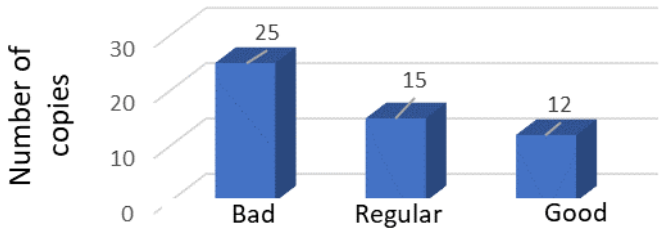
Figure 14 : Distribution of the 52 tree specimens in the category referring to trees and their distance to buildings and buildings.



According to Mascaró and Mascaró (2005), large trees with a superficial root system should be avoided in the afforestation, so that there is no damage to the walks made on the site. The choice of tree species should be based on criteria where the size of the plant size is considered with the environment where the tree will grow.

According to Figure 15, of the 52 specimens, 35 presented a distance between trees of 2 to 5 meters, where they obtained a score of 2. Following 12 specimens with grade 1, which presented less than 2 m from one to the other, generating competition between the species for light and nutrients. The smallest number of specimens (5) was concentrated in note 3 where the distance between them was greater than 5 m.

Figure 15: Distribution of the 52 tree specimens in the category referring to the distance to the nearest species.

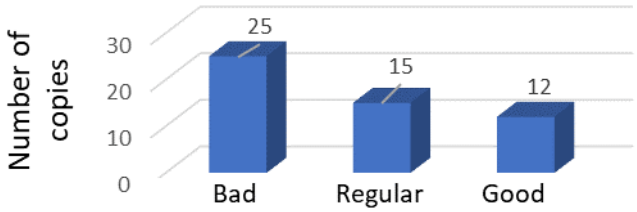


Araújo and Araújo (2016), cite that the spacing between trees should also consider the adult size of the species to be planted, for small size, the spacing should be 7 m, for medium size, 10 m and for large size, 15 m.

Research such as that of Pretzsch et al. (2015) evaluating species commonly used in street afforestation and green areas of 9 metropolises (Sapporo, Japan; Munich Germany; Brisbane, Australia; Hanoi, Vietnam. Prince George, Canada; Paris, France; Cape Town, South Africa; Santiago de Chile, Chile), demonstrated the importance of the theme of compatibility, since these authors identified the need to estimate the specific spatial requirements for each species in order to evaluate the benefits and risks of incompatibility in urban planning processes.

Regarding the distance parameter to the sidewalk or curb, it is observed, through figure 16, that 52 specimens present grade 1, that is, distance less than 2 m from the trees to the sidewalks or curb, accounting for all the species analyzed, which can occur problems such as the lifting of sidewalks and curbs, clogging of pipes. Therefore, it is of paramount importance to plan in choosing the species, its size and the area of implantation always must be analyzed and managed correctly.

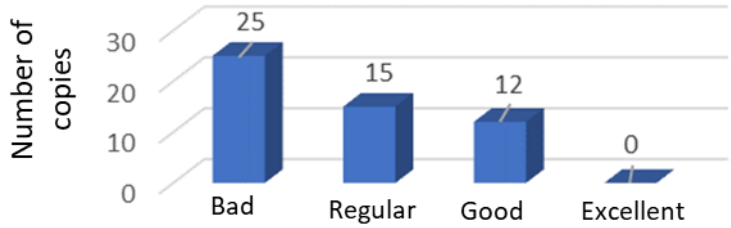
Figure 16: Distribution of the 52 specimens in the category referring to trees and their distance to the sidewalk or curb.



According to Aracruz (2013), for pavements with a width between 1.50 m and 2.0 m, it is recommended to plant only small trees, if the width is greater than 2.00 m and less than 2.40 m, only small and medium-sized trees and small and medium trees up to 8.00 m in height.

The analysis of the data presented showed a diagnosis of Praça João Pedro Menna Barreto after analysis of 15 parameters that obtained results from 25 trees diagnosed as very poor, 15 in regular condition, 12 in good condition and no excellent individual (figure 17).

Figure 17: Distribution of the 52 specimens showing the classification of the conditions in which they are found.



Teixeira and Nunes (2019) in a study in Praça Eufrásio Corrêa, Curitiba – PR, obtained as a result after analyzing the parameters of the diagnosis of the condition of the 89 tree specimens inventoried in the Square, 15 of these presented EXCELLENT condition, other 45 were categorized with a GOOD condition, 24 in REGULAR situation and only 5 of them in TERRIBLE situation.

4 CONCLUSIONS

Through the analysis of the results obtained in this study, it can be concluded that the methodology used is efficient and practical in the rapid analysis of the situation of a tree specimen that is being evaluated and is able to generate information to facilitate the process of formation of a database and comparison with other similar methods. However, it is important to note that this methodology generates empirical and subjective information and, therefore, has limitations in its efficiency.

Most of the specimens, 25, were diagnosed in the very bad category, demonstrating that the afforestation of Praça João Pedro Menna Barreto is in precarious conditions, requiring proper management and suppression of some dead specimens. There are 15 trees that presented regular condition, in which it is still necessary to have an adequate management before major problems such as death of the fallen tree and 12 trees presented good condition, being necessary the management of these specimens.

Finally, the techniques of management and cultivation of urban trees, through a Management Plan, allow efficient strategies with regard to the conservation and management of tree specimens, aiming to contribute to the development of plants, including respect for the natural dimension of forest species.

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