Urban Afforestation and Sidewalks: a Research on The Streets of The City of Juiz de Fora, Minas Gerais, Brazil

Arborização viária e calçadas: Um estudo em ruas do município de Juiz de Fora, Minas Gerais – Brasil

Forestación vial y aceras: un estudio sobre las calles de la ciudad de Juiz de Fora, Minas Gerais – Brasil

Crislaine da Silva Ramos

Master Student, UFJF, Brazil.
crislaine.ramos@estudante.ufjf.br
ORCID iD 0009-0001-3902-8487

Meir de Jesus Gomes

Geography Undergraduate Student, UFJF, Brazil.
meir.gomes@estudante.ufjf.br
ORCID iD 0009-0005-4576-9360

José Alberto Barroso Castañon

Ph.D. Professor, UFJF, Brazil.
jose.castanon@ufjf.br
ORCID iD 0000-0002-9799-6857

Cézar Henrique Barra Rocha

Ph.D. Professor, UFJF, Brazil.
barra.rocha@engenharia.ufjf.br
ORCID iD 0000-0003-1321-158X

RESUMO

O aumento no número de habitantes trouxe consigo a demandas pelo planejamento urbano no intuito de atenuar os problemas existentes, minimizar a possibilidade de surgimento de outros e principalmente garantir um ambiente urbano agradável e sustentável para as presentes e futuras gerações. Dentre as demandas presentes no meio urbano encontram-se as vias públicas e, consequentemente, as calçadas e a arborização. Assim, este trabalho alude às questões relacionadas a caminhabilidade, principalmente no que tange a arborização urbana e as condições das calçadas, com o intuito de contribuir com conhecimentos acerca do tema, aplicando os estudos em quatro ruas divididas entre dois bairros do perímetro urbano de Juiz de Fora (MG), o Bairro Centro e o Bairro São Pedro. O trabalho se dispõe a fazer uma análise das calçadas e suas condições frente à arborização. Para a execução da pesquisa foi realizada coleta de dados remotamente através do *Google Earth* e *Street View*. Os resultados apontaram 124 espécimes vegetais, arbóreos e arbustivos entre as 4 ruas. Além disso, foi possível constatar que apesar de ser considerado um dos bairros com maior presença de áreas verdes, quando avaliada a vegetação viária, o bairro São Pedro indicou similaridades ao bairro Centro, caracterizado como um dos que possuem menor índice de áreas verdes, apresentando 60 e 64 indivíduos arbóreos, respectivamente. Contudo, salienta-se a necessidade de estudos mais aprofundados sobre o tema.

PALAVRAS-CHAVE: Arborização, Calçadas, Caminhabilidade.

SUMMARY

The increase in the number of inhabitants brought with it demands for urban planning in order to alleviate existing problems, minimize the possibility of others arising, and primarily ensure a pleasant and sustainable urban environment for present and future generations. Among the demands present in the urban environment are public roads and, consequently, sidewalks and urban greenery. Thus, this work addresses issues related to walkability, particularly concerning urban greenery and the conditions of sidewalks, with the aim of contributing knowledge on the subject by applying studies on four streets divided between two neighborhoods in the urban perimeter of Juiz de Fora (MG), the Centro neighborhood and the São Pedro neighborhood. The work aims to analyze the sidewalks and their conditions in relation to greenery. For the execution of the research, data was collected remotely through Google Earth and Street View. The results indicated 124 plant specimens, both trees and shrubs, across the four streets. Furthermore, it was found that despite being considered one of the neighborhoods with the highest presence of green areas, when evaluating roadside vegetation, the São Pedro neighborhood showed similarities to the Centro neighborhood, characterized as one with the lowest rate of green areas, presenting 60 and 64 tree individuals, respectively. However, the need for more in-depth studies on the subject is emphasized.

KEYWORDS: *Urban Afforest, sidewalk, Walkability.*

RESUMEN

El aumento en el número de habitantes trajo consigo demandas de planificación urbana con el fin de mitigar los problemas existentes, minimizar la posibilidad de aparición de otros y, principalmente, garantizar un ambiente urbano agradable y sostenible para las generaciones presentes y futuras. Entre las demandas presentes en el entorno urbano se encuentran las vías públicas y, en consecuencia, las aceras y la arborización. Así, este trabajo alude a cuestiones relacionadas con la caminabilidad, principalmente en lo que respecta a la arborización urbana y las condiciones de las aceras, con el objetivo de contribuir con conocimientos sobre el tema, aplicando estudios en cuatro calles divididas entre dos barrios del perímetro urbano de Juiz de Fora (MG), el barrio Centro y el barrio São Pedro. El trabajo se propone hacer un análisis de las aceras y sus condiciones frente a la arborización. Para la ejecución de la investigación se realizó la recopilación de datos de forma remota a través de Google Earth y Street View. Los resultados indicaron 124 especímenes vegetales, arbóreos y arbustivos, en las 4 calles. Además, se constató que, a pesar de ser considerado uno de los barrios con mayor presencia de áreas verdes, al evaluar la vegetación vial, el barrio São Pedro mostró similitudes con el barrio Centro, caracterizado como uno de los que tienen el menor índice de áreas verdes, presentando 60 y 64 individuos arbóreos, respectivamente. Sin embargo, se destaca la necesidad de estudios más profundos sobre el tema.

PALABRAS CLAVE: *Forestación urbana, Aceras, Caminabilidad.*

1 INTRODUCTION

The migration from rural to urban areas, driven, mainly, by the Industrial Revolution and the possibility of improving quality of life, leads to the emergence of cities with a huge demographic density but insufficient structure to meet the news needs. This event has economic, social, and environmental consequences that directly affect the quality of human's life.

The increase in the number of inhabitants has brought with it the demand for urban planning, with the intention to mitigate the existence problems and to reduce the possibility of new problems appearing. Thus, this planning can be defined as an action of the public authority to determine the best way to use and occupy the area, taking into account data and evaluating other alternatives and public policies (SEMIL, 2021).

Among the real needs of the urban area, there are the public roads, and, therefore, the sidewalks. The sidewalks are elements of high relevance to urban infrastructure and mobility, and if they are well planned, they can allow an adequate walk, autonomy and safety for the pedestrians (Aguiar, 2003; ABCP, 2014). In addition, they can also contribute to the embellishment of the urban environment, especially when there are trees and shrubs.

The presence of urban afforestation in the streets and avenues is directly linked to shading, to reduce noise and atmospheric pollution and to improve the microclimate, it also contributes to the preservation of fauna and flora specimens (Pivetta; Silva Filho, 2002; Costa et al., 2023). But when it is not planned, this presence can contribute to negative impact in the community, such as damage to the electric wiring, to the sidewalks infrastructure and even socio-economic losses due to falling trees in storms. This highlights the need for more detailed projects and studies about the subject. So, besides evaluating the situation of urban afforestation and walkability in the public roads of Juiz de Fora, this work has the purpose to contribute to the knowledge about the relationship between sidewalks and afforestation through exploratory research.

1.1 Urban Infrastructure

The demographic growth has increased the demand for urban spaces, it created the need to develop mechanisms capable of supplying the services and the activities arising from the population in cities. In this sense, it should be noted that the way in which a locality is structured, such as the necessary changes to it, is directly connected to infrastructure (Morais; Sobreira; de Lima, 2018).

The urban infrastructure, according to Zmitrowicz and Angelis Neto (1997, p. 2) can be understanding as:

> [...] a technical system of equipment and services necessary to development of urban functions, which can be seen from the social, economic and institutional aspects. From the *social aspect*, urban infrastructure aims to promote adequate conditions for housing, work, health, education, entertainment and security. From an *economic point of view*, urban infrastructure should promote the development of productive

> activities, in other words, the production and trading of goods and services. And from the *institutional perspective,* urban infrastructure should provide the necessary paths for the development of political and administrative activities, including the management of the city itself. (Zmitrowicz; Neto, 1997, p. 2, own translation)

In this way, the authors defined the urban infrastructure as a service that is provided as an answer to the needs of the city, making it a variable capable of conditioning, improving and indicating the development in different areas, as well as economic and territorial development (Institute of Applied Economic Research, 2010; Morais; Sobreira; de Lima, 2018).

1.2 Sidewalks

Due to the urge of locomotion and transport, it is believed that the oldest component of urban infrastructure is the road networks. It should emerge, sequentially of that component, a want of security areas of pedestrian traffic: the sidewalks.

According to the Brazilian Federal Law No. 9.503/97, the sidewalk can be defined as "part of the road, normally segregated and in a different level, it does not destined to vehicles traffic, it is reserved to pedestrian traffic, and when it is possible to implementation of street furniture, signalization, vegetation and others" (own translation). Thus, there are different types of sidewalks.

The types of sidewalks are different mainly according to the material used in its confection. There are some examples: interlocking pavement; precast panels; stamped concrete; hydraulic tile; and green sidewalk (Sartori, 2018).

The NBR 9050 from 2015 showed the minimum dimensions that sidewalk have to be, dividing them in three lanes:

● Service Lane: it should have a minimum width of almost 0.40 in., it is for seedbed, trees, poles and/or signalization.

● Free lane or walk: it should have "a transverse tilt cross slope of up to 3%, be continuous across lots and it should have minimum width of 43.24 in. and 82.68 in. of clear height" (Brazilian Association of Norms Techniques, 2015, p. 74, own translation), and it is for free mobility of the pedestrians.

● And Access Lane: present just in sidewalks with width of more than 78.74 in., "it should have to accommodate the access ramp to neighboring properties with the approval of the municipality for buildings already built." (Brazilian Association of Norms Techniques, 2015, p. 74, own translation).

In terms of accessibility, it is recommended a campable width to provide an easy traffic of pedestrians and to supply the needs of people with disabilities, as well as use appropriate floorings, coatings, slopes and gradients, thus maximizing traffic flow and promoting mobility. (Brazilian Association of Portland Cement, ABCP, 2014; Study and Research Center of Public Administration, CEPAM, 2008).

1.3 Urban Afforestation

The existence of trees in urban areas perform important and distinct functions, bringing with them extensive benefits in the perspectives of aesthetic, ecological/climatic, economic, spiritual, health and social relations (Santos, 2022). This highlights the importance of the existence of such individuals, especially in city environments.

The urban afforestation can be understood as road and sidewalk trees, such as trees in any place, as long as these trees are products of man-made planting (Gonçalves, 2022). In addition, according to Brazilian Association of Portland Cement (2014):

> The vegetation planting in sidewalks should be done in a ways that ensures that accessibility in the pavement is maintained. So, the sidewalk should have a minimum width that allows, besides the lane where the plantation will occur, also an area destined to a 47.24 in. free lane. It is recommended that seedbed and tree planting take place in the service lane, as long as the specimens do not get in the way of the overhead wiring. The choice of the vegetation specimens should follow the guidance of the relevant municipal body. (Brazilian Association of Portland Cement, 2014, own translation)

Previous to the act of afforestation/planting of the tree individuals in an specific location, its indispensable planning and adequate itself to the already existent cities structures, that will boost the benefits and mitigate the risks from the inadequacy for those structures. That specimens also demand a high maintenance.

Therefore, with the aim of mitigating those risky occurrences, emerge the urge to analyse which tree specimens are more adequate to the urban environment. Some specimens can be classified as appropriated to the cities (Board 1), according to their size, sidewalk width, overhead wiring, property, elements and the street furniture in the sidewalks of streets and avenues.

Board 1: Brazilian native specimens appropriate for urban environments.

Size	Scientific Name	Popular Name	Height
Small	*Dictyoloma vandellianum*	Tingui-preto	157-275 in.
Small	*Handroanthus heptaphyllus var. paulensi*	Ipê-rosa-anão	118-196 in.
Small	*Bauhinia longifolia*	Unha-de-vaca	157-275 in.
Small	*Psidium cattleianum*	Araçá	118-236 in.
Medium	*Cassia leptophylla*	Falso barbatimão	314-393 in.
Medium	*Cordia superba*	Babosa Branca	275-393 in.
Medium	*Handroanthus chrysotrichus*	Ipê-amarelo	157-393 in.
Medium	*Licania tomentosa*	Oiti	314-590 in.
Large	*Caesalpinia peltophoroidde*	Pata de vaca	275-393 in.

Large	*Handroanthus impetiginosus*	Babosa Branca	275-393 in.
Large	*Albizia niopoides*	Farinha seca	393-787 in.
Large	*Astronium graveolens*	Guaritá	590-984 in.

Source: Adapted from Technical Manual of Urban Afforestation, 2015.

1.4 Walkability

When the subject is sidewalk and afforestation, it is unacceptable not to talk about walkability, which main focuses is the pedestrian and their mobility around the urban space. In this perspective, walkability values the quality of mobility spaces and the accessibility to them, providing users a good experience in the path through where they intend to pass.

Ghidini (2011, p. 22) says that walkability "should offer some motivation to induce more people to adopt walking as an effective mechanism of displacement, re-establishing their interdependent relationships with the streets and neighborhoods" (own translation). It is interesting to keep in mind that the study of walkability considers the fiscal attributes of the area – as the sidewalk characteristics and the street furniture disposition –, but also it should consider the socio-spatial relations.

So, a good visual and attractive impression of the area is important to a pedestrian's positive experience. Lima and Jeronymo (2021, p. 1392) realized that "it is not enough to have a pavement good for walking; the urban environment needs elements visually and psychologically attractive to be considered walkable" (own translation). For that objective the afforestation is an excellent attractive and functional alternative, because it brings benefits to the place user through the path shading; reducing the ambient temperature; improving air's quality, and even improving the public health by encouraging walking, as well as contributing to the visual aesthetics of the urban landscape.

Since, implementing practices aimed at developing better conditions of walkability to the pedestrians it is essential to public administration and professionals in the field. In this context, De Araújo *et al. (*2019) emphasized the importance of the presence of professionals who are focused on this urban mobility field that is walkability, and engaged with this.

> It is up to all the techniques and researchers involved in landscape to contribute to the production of people-orientated zones, allowing them to walk comfortable, establish social, cultural, historical and ambiental relationships, and to create positive emotional ties that connect then with landscapes and arouse their interest in maintain it for the future generation. (DE ARAÚJO *et al.*, 2019, p. 15, own translation)

The existence of public policies aimed at pedestrians is necessary to discourage the use of motorized transport, such as saloon cars, which impact the street furniture and reduce the quality of life in the cities.

2 OBJECTIVE

To know the main contributions provided by road afforestation to the urban environment, and also to evaluate the criteria and variables which influence the walkability in the streets and avenues of this research.

3 METHODOLOGICAL PROCEDURES

To carry out the proposed research, a case study design was used, as defined by Gil (2022). To this end, this research was based on reading the existing biography literature about the subjects covered here, and then, there was a data collection using Geographic Information System (GIS) tools, as Google Earth and Street View. Those tools have the aim of checking the sidewalks' conditions in relation to the trees on them and their impact on walkability. The Excel tool was also extremely useful for carrying out statistical analyses of the data and for generating graphs.

3.1 Study Area

The public roads studied here are localized in the city of Juiz de Fora, in Minas Gerais, Brazil, in the microregion of Zona da Mata Mineira. The city has a total area of 1,433.87 km², of which 440 km² is urban (Participatory Master Plan, 2018). Currently, Juiz de Fora has around 541,000 inhabitant (IBGE, 2022), and in terms of green areas has around 55.55% of public roads afforestation (IBGE, 2010). It should also be noted that it is one of the Brazilian cities with the highest number of registered cars: 191,137, according to a report made in April 2024 by the National Traffic Secretariat (SENATRAN), about one car for which 3.5 inhabitants. This makes the city the 4th city in Minas Gerais with the highest number of registered cars, behind only Contagem, Uberlândia and the capital Belo Horizonte.

Furthermore, the sample space of this research consists of two streets localized in the Centro neighborhood and two streets of the São Pedro neighborhood, component of the regions central and west of Juiz de Fora's urban perimeter. Those neighborhoods are the one with the most green areas and the one with the lowest rate of green areas in the city, respectively. Moreover, those streets were identified and, after, evaluated and selected because of the viability of the study.

The streets and avenues chosen in the city are among those with the highest flow of pedestrians and cars, according to IBGE (2015). They are: Halfeld Street and Getúlio Vargas Avenue, in the Centro neighborhood, and João Krolman Sobrinho Street and Senhor dos Passos Avenue, localised in the São Pedro neighborhood (Figure 1).

Figure 1: Delimitation of The Study Area.
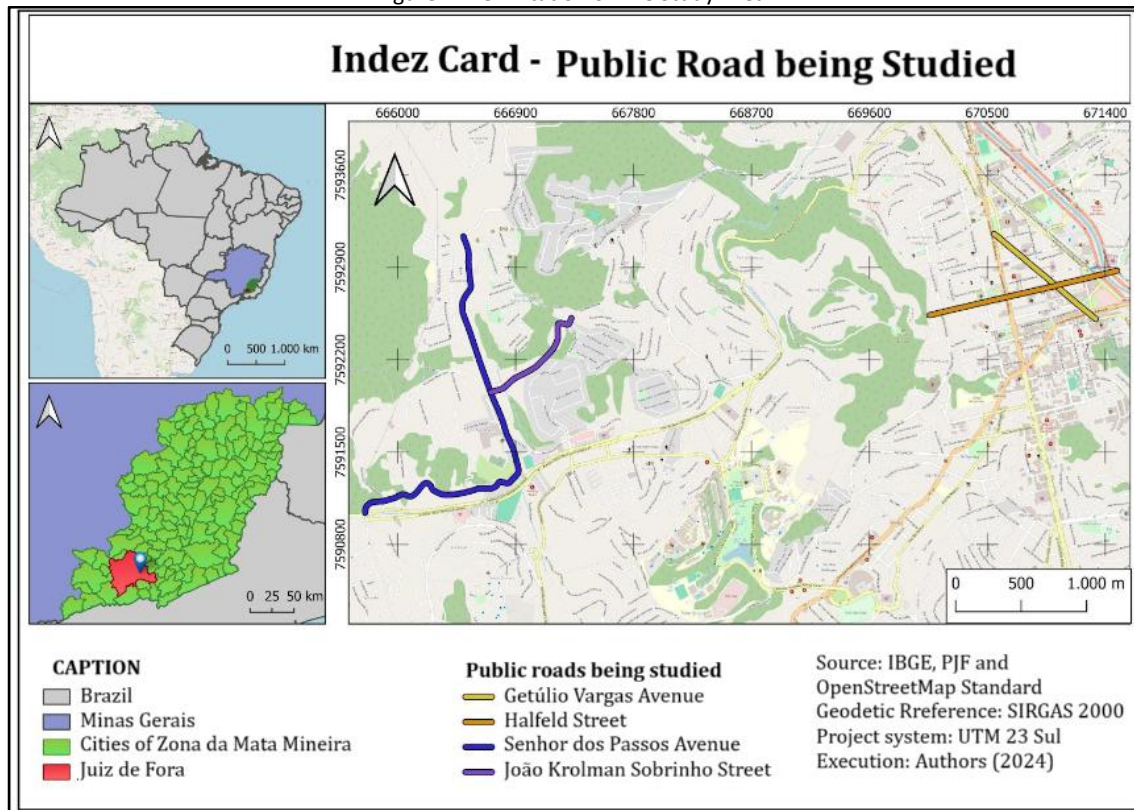
Source: Our Own Elaboration.

3.2 Data Collection

The Data Collection was made between november and december of 2023 by remote sensing tools: *Google Earth* and *Street View*. But the images used were about 2021 and 2022. In this way, it was collect data about:

- The existence of trees and shrubs.
- The types of sidewalks.
- The presence of seedbeds.
- The root situation in relation to the sidewalk.

Next, the data were organised through spreadsheets and analysed os dados foram organizados através de planilhas e analisados using statistical analysis programmes. Subsequently, they were consolidated in graphs for better interpretation and understanding.

4 RESULTS

In the final count, 124 specimens of vegetables, trees and shrubs were found among four streets divided in two neighborhoods. 35 trees in Halfeld Street, 29 individuals in Getúlio Vargas Avenue, both in the Centro neighborhood, and 7 specimens in João Krolman Sobrinho

Street and 53 individuals in the Senhor dos Passos Avenue, both address part of the São Pedro neighborhood.

4.1 Sidewalks

Paving the sidewalks is linked with water and air absorption, as well as with the development of the trees' and shrubs' roots planting in cities public roads (Pivetta; Silva Filho, 2002).

In this present research, 34% (42) of the individuals are on sidewalks made of concrete, 21% (26) hydraulic tile, 18% (22) Portuguese pavement and 11% (14) packed earth paths. In smaller numbers, vegetables were found on sidewalks made by concrete and packed earth (7.6%), flooring (5.4%), stamped concrete (5.4%), and on sidewalks made by precast panels (1%). In just two cases (1%) it was not possible to identify (Figure 2).

Figure 2 - Sidewalks Material
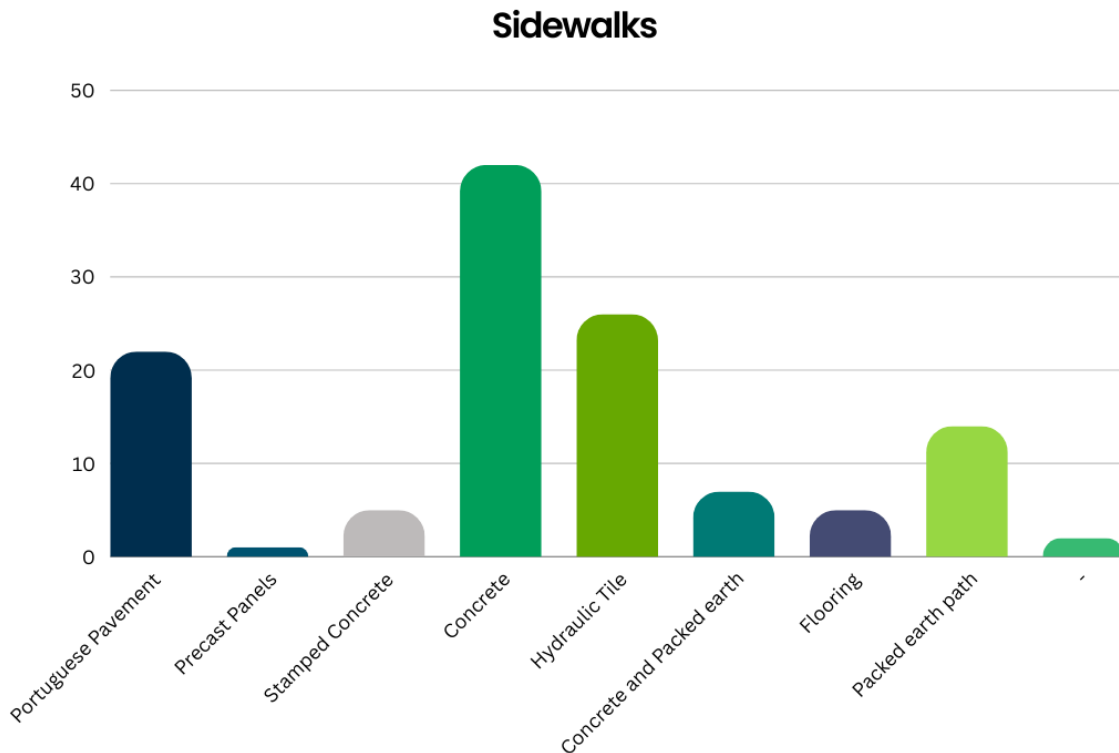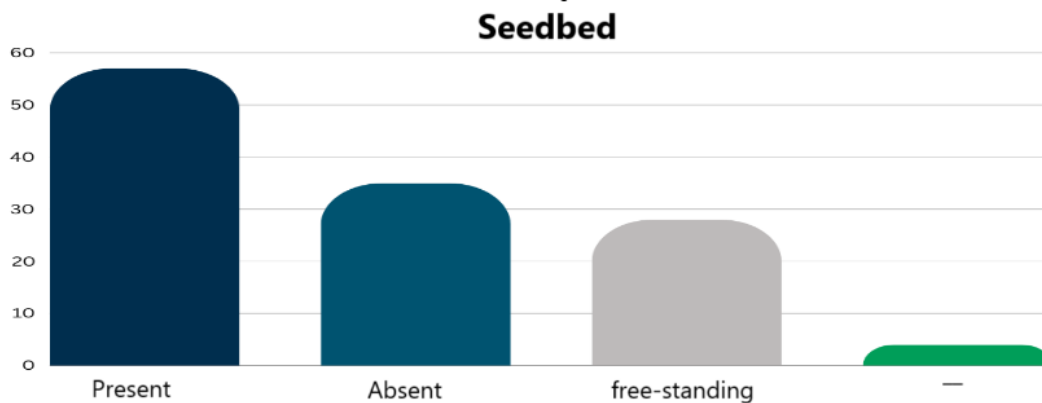

Source: Our Own Elaboration.

Zabot (2013), Duarte Júnior and collaborators (2024) say that the physical structure of sidewalks, their leveling, dimensions and material, are linked with the pedestrian's flow, being, consequently, directly connected with walkability and mobility.

4.2 Seedbed

For the presence of seedbed (Figure 3), around 46% (57) of the trees are surrounded by them; in 28% (35) had no seedbed. However, the individual tree was completely suppressed by the sidewalk pavement; these cases were detected especially on concrete pavements.

Among the vegetables analysed, 23% (28) were free-standing, planted without the interference of seedbed or any other object/material around. In four cases (3%), it was impossible to observe if there was presence or absence of seedbed.

Figure 3 - Seedbeds

Source: Our Own Elaboration.

The existence of seedbeds enclosing the trees and shrubs can cause some harm, as they reduce the permeable surface and hamper the root flowing (Bobrowski; Biondi; Baggenstoss, 2009). Therefore, the inspection and maintenance in order to provide the health of the vegetables present in the urban afforestation is so important.

4.3 Sidewalk vs. Tree Roots

This research indicated that 86% (107) of the analyzed specimens are in good condition (Figure 4), they did not present visible roots or cracks in the sidewalks. But 12% (15) individuals showed an obstruction in the sidewalks, with the presence of roots overlapping the sidewalk and/or damaging any part of it (Figure 5). In two trees (2%), it wasn't possible to verify the situation.

Figure 4 - Relationship Between Sidewalks and Roots
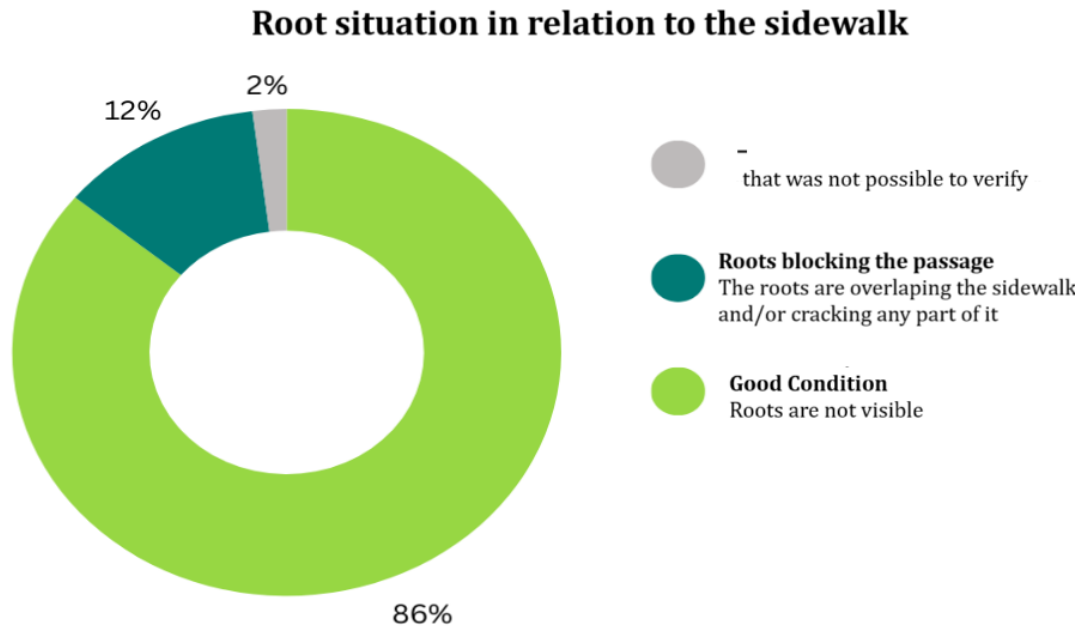
Source: Our Own Elaboration.

Figure 5 - Roots Overlapping The Sidewalks. (A) Halfeld Street; (B) Getúlio Vargas Avenue.

Source: Street View by Google Earth, 2022.

Similarly results were found in a research carried out by Albertin *et al.* (2014) on Joubert de Carvalho Street in Maringá (Paraná-Brazil), in which around 92% of the trees didn't present upwelling, then not causing damage to the sidewalks.

So, it is very important to study the relationship between sidewalks and the tree's and shrubs' roots, because that is directly connected with mobility, accessibility, and the security of the paths in the urban environment. When this relationship is implemented without planning, it can influence the walkability of the pedestrians in a negative form.

4.4 The Neighborhoods

The analysis between the studied neighborhoods here pointed out the largest number of trees and shrubs in the Centro neighborhood; there are 64 individuals sampled between Halfeld Street and Getúlio Vargas Avenue. And the São Pedro neighborhood showed 60 specimens distributed between João Krolman Sobrinho Street and Senhor dos Passos Avenue.

About the sidewalk material, most of the trees in Centro neighborhood are localized on sidewalks made by hydraulic tile or Portuguese pavement. On another hand, the arboreal individuals of the São Pedro neighborhood are localized on concrete sidewalks or on packed earth paths (Board 2).

Board 2: Neighborhoods Sidewalks Analysis.

Sidewalk Material	Centro	São Pedro
Portuguese Pavement	21	0
Precast Panels	1	0
Stamped Concrete	3	0
Concrete	12	29
Hydraulic Tile	25	0
Concrete and Packed earth	0	6
Flooring	0	4
Packed Earth path	0	21
-	2	0

Source: Our Own Elaboration.

A similarity between the numbers found in the analysis was verified in the relationship between the sidewalks and the roots of the trees, the neighborhoods Centro and São Pedro presented 53 and 54 with sidewalks and roots in good conditions (Board 3), respectively. And they only presented 9 (Centro) and 6 (São Pedro) sidewalks where roots are blocking the passage.

Board 3: Relationship Between Sidewalk and Afforestations.

Sidewalk vs. Roots	Centro	São Pedro
Sidewalk in good condition	53	54
Roots are blocking the passage	9	6
-	2	0

Source: Our Own Elaboration.

5 CONCLUSIONS

The infrastructure of the cities is connected with human's development in the urban environment, it can foster benefits, especially when they are well planned and executed. Thus, studies regarding the topic of afforestation are essential, as well as the ones about its relationship with the mechanisms and the objects from the urban area.

It is possible to say that, despite being considered one of the neighborhoods with most green areas in the city, when the street and avenue afforestation is putted under evaluation the São Pedro neighborhood and the Centro are similar, even though Centro is one of the lower rates of green areas in Juiz de Fora.

Analyzing the information collected in this research, it can be observed that tree implementation in the public streets, beyond the proposal to embellish the place and to improve the quality of life, requires plan and maintenance to maximize the benefits of this connection.

It is also important to identify the trees and shrubs specimens found to deepen our expertise, and make it possible to indicate the potential damages caused in the underground power grid and in the water and sewer pipeline, by the roots.

ACKNOWLEDGMENTS

References

AGUIAR, F. O. **Análise de Métodos Para Avaliação da Qualidade de Calçadas**. Dissertação (Mestrado em Engenharia Urbana). Universidade Federal de São Carlos, São Carlos, 2003.

ASSOCIAÇÃO BRASILEIRA DE CIMENTO PORTLAND. Projeto técnico: Calçadas acessíveis. São Paulo, 2010. Disponível em: https://solucoesparacidades.com.br/wp-content/uploads/2014/11/AF_CALCADAS_web.pdf. Acesso em: 29 nov. 2023.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 9050: **Acessibilidade a edificações, mobiliário, espaços e equipamentos urbanos**. Rio de Janeiro, 2015. Disponível em: http://acessibilidade.unb.br/images/PDF/NORMA_NBR-9050.pdf.

BRASIL. Lei Federal nº 9.503, de 23 de setembro de 97. Institui o Código de Trânsito Brasileiro. Diário Oficial da União: Brasília, DF. Disponível em: https://www.planalto.gov.br/ccivil_03/leis/l9503compilado.htm. Acesso em: 28 nov. 2023.

BOBROWSKI, R.; BIONDI, D.; BAGGENSTOSS, D. Composição de canteiros na arborização de ruas de Curitiba (PR). Revista da Sociedade Brasileira de Arborização Urbana, Piracicaba, v.1, n.1, p.44-61, 2009.

CENTRO DE ESTUDOS E PESQUISAS DE ADMINISTRAÇÃO MUNICIPAL (CEPAM). **Acessibilidade nos Municípios:** Como aplicar o Decreto n° 5.296/04. São Paulo, 2008. Disponível em: https://www.mpsp.mp.br/portal/page/portal/Cartilhas/Acessibilidade_nos_municipios.pdf. Acesso em: 20 nov. 2023.

COSTA, F. G.; GARCIA, L. H. C.; RIBEIRO, A. P.; OLIVEIRA, A. de. O Fenômeno de Ilhas de Calor e o Papel da Arborização Urbana Para Mitigá-lo: Um Estudo em Ituverava, Região Nordeste do Estado de São Paulo, Brasil. **Periódico Técnico e Científico Cidades Verdes**, *[S. l.]*, v. 11, n. 30, 2023.

DE ARAUJO, M. C. P. B.; FERREIRA, K. P. S.; GOMES, A. K. P. T.; LIMA, G. S.; CAVALCANTI, M. I. M. **Análise acerca da caminhabilidade a partir dos valores paisagísticos e da arborização urbana no centro de Pau dos Ferros/RN**. In: ASOCIACIÓN DE ESCUELAS Y FACULTADES PÚBLICAS DE ARQUITECTURA DE AMÉRICA DEL SUR, Belo Horizonte, 2019. Anais [...]. Campinas, Galoá, 2019.

DUARTE JÚNIOR, D. S.; JESUS, L. M. de; SANTO, F. S. E. Arborização urbana não planejada como barreira à acessibilidade: Um estudo de caso em Jequié – BA. **Periódico Técnico e Científico Cidades Verdes**, *[S. l.]*, v. 12, n. 37, 2024.

GHIDINI, R. A caminhabilidade: medida urbana sustentável. **Revista dos Transportes Públicos–ANTP**. São Paulo, v. 33, 2011.

GIL, A. C. Como elaborar projetos de pesquisa. 7 ed. Barueri: **Atlas**. 2022.

GONÇALVES, W. História da Arborização Urbana. In. **Arborização Urbana:** Considerações sobre planejamento, implantação, manejo e gestão. – Belo Horizonte: Companhia Energética de Minas Gerais (CEMIG), 2022.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Acervo dos municípios brasileiros: Rua Halfeld, Juiz de Fora, MG. Juiz de Fora, 2015. Disponível em: https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=445327. Acesso em: 15 nov. 2023.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Cidades e Estados. Juiz de Fora. 2022.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Juiz de Fora. 2010. Disponível em: https://cidades.ibge.gov.br/brasil/mg/juiz-de-fora/panorama. Acesso em: 25 out. 2023.

INSTITUTO DE PESQUISA ECONÔMICA APLICADA (IPEA). **Infraestrutura social e urbana no Brasil: subsídios para uma agenda de pesquisa e formulação de políticas públicas**, v. 2 (912 p.) Brasília, 2010.

JUIZ DE FORA. Plano Diretor Participativo: Sistema JFLegis. Disponível em: https://jflegis.pjf.mg.gov.br. Acesso em: 25 out. 2023.

LIMA, Erick Salviano; JERONYMO, Caroline Muñoz Cevada. A caminhabilidade como medida da mobilidade urbana: análise do centro de Brejo Santo, Ceará. **Revista Principia - Divulgação Científica e Tecnológica do IFPB,** João Pessoa, 2022.

MANUAL TÉCNICO DE ARBORIZAÇÃO URBANA. Prefeitura de São Paulo – Verde e Meio Ambiente. São Paulo, 2015. Disponível em: https://cms.sosma.org.br/wp-content/uploads/2015/03/MANUAL-ARBORIZACAO_22-01-15_.pdf. Acesso em: 20 nov. 2023.

MORAIS, G. A. S.; SOBREIRA, D. B.; LIMA, J. E. Padrão e determinantes da infraestrutura urbana das microrregiões brasileiras. **Geosul**, Florianópolis, v. 33, n. 66, p. 262-291, jan./abr.2018.

PIVETTA, K. F. L.; SILVA FILHO, D. F. da S. **Arborização Urbana**. Boletim Acadêmico - Série Arborização Urbana. Disponível em: https://sites.usp.br/podalab/wp-content/uploads/sites/1036/2022/01/000-USP-ESALQ-arborizacao_urbana-Khatia.pdf. Acesso em: 13 dez. 2023.

SANTOS, dos S. Arborização no Contexto do Planejamento Urbano. In. **Arborização Urbana: Considerações sobre planejamento, implantação, manejo e gestão**. – Belo Horizonte: Companhia Energética de Minas Gerais (CEMIG), 2022.

SARTORI, E. M. **Análise da tipologia das calçadas na região central de Salto do Lontra – PR**. Trabalho de Conclusão de Curso (Bacharelado em Engenharia Civil). Universidade Tecnológica Federal do Paraná, Pato Branco, 2018. Disponível em: https://repositorio.utfpr.edu.br/jspui/bitstream/1/14356/1/PB_COECI_2018_2_52.pdf. Acesso em: 28 nov. 2023.

SECRETARIA DE MEIO AMBIENTE, INFRAESTRUTURA E LOGÍSTICA (SEMIL)**. Dicionário ambiental: planejamento territorial. São Paulo,** 2021. Disponível em: https://semil.sp.gov.br/educacaoambiental/prateleira-ambiental/planejamento-territorial/. Acesso em: 13 dez. 2023.

SECRETARIA NACIONAL DE TRANSPORTES. **Frota de veículos - 2024.** Ministério dos Transportes, Brasil, 2024.

ZABOT, C. de M. **Critérios de avaliação da caminhabilidade em trechos de vias urbanas: Considerações para a região central de Florianópolis**. Dissertação (Mestrado em Arquitetura e Urbanismo). Faculdade de Arquitetura e Urbanismo da Universidade Federal de Santa Catarina. 2013.

ZMITROWICZ, W.; ANGELIS NETO, G. **Infraestrutura Urbana**. São Paulo: EPUSP, p. 40, 1997.